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QUESTIONS AND ANSWERS ON GUNNERY, ETC.

F. W. PANZERA.

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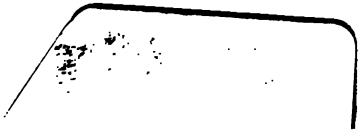

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QUESTIONS AND ANSWERS

ON

GUNNERY,

ETC.

FOR THE USE OF OFFICERS OF THE AUXILIARY FORCES AT WOOLWICH AND SHOEBURYNESS.

BY

LIEUT. PANZERA,

SECOND BRIGADE N.I.D. ROYAL ARTILLERY.

LONDON:
WILLIAM CLOWES AND SONS, LIMITED,
13, CHARING CROSS.

1882.

PREFACE.

HAVING spent several months altogether at Woolwich and Shoeburyness, and passed all the examinations open to Officers of Auxiliary Forces, I have been struck with the want felt by many men of a book of *questions and answers* on the usual subjects of examinations in gunnery, similar in plan to Major Thompson's excellent book, 'The Militia Officer's Examiner.'

I have humbly endeavoured to meet this want in the following pages, which contain every question likely ever to be asked a Militia Officer at Woolwich or Shoeburyness. I have left out questions on Gun and repository *drill*. The former I assume every officer to have a *thorough practical* knowledge of, and the questions on the latter nearly always relate to some operation which has been performed during the course.

F. W. P.

HARWICH, *June 19th*, 1882.

ERRATA.

Page 9, line 26, *for* "out of a much heavier gun," *read* "out of a much lighter gun."

,, 18, line 6, *for* "81-ton gun," *read* "80-ton gun."

,, 33, line 4, Case shot *for* "600 yards," *read* "400 yards."

,, 35, line 10 from bottom, *for* "tunnel," *read* "funnel."

,, 44, answer to first question, *for* "inwards," *read* "in yards."

NOTES.

Page 34. N.B.—Bags for bursting charges of shell are now *discontinued* for 64-prs., 80-prs., and howitzers.

,, 37. N.B.—All shell for 8" guns and upwards are now made *studless*.

,, 44. N.B.—Boxes of strands of gun-cotton will in future only be issued for 7-prs. and howitzers in siege trains.

,, 45. N.B.—The manufacture of delay-action fuzes is discontinued.

,, 76. N.B.—Of course the answer "backwards" is ironical. A proper answer (if the question ever occurred) would be "according to the prescribed nomenclature of the vocabulary issued by the War Office."

QUESTIONS AND ANSWERS

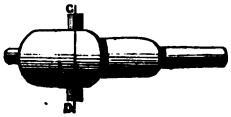
ON

GUNNERY.

Q.—Give the definitions of gunnery terms, with diagram illustrating each.

A.—(1) *Calibre.*—The diameter of the bore. In rifled guns measured across the lands, A.

(2) *Axis of Piece.*—An imaginary line passing through the centre of the bore, A B.



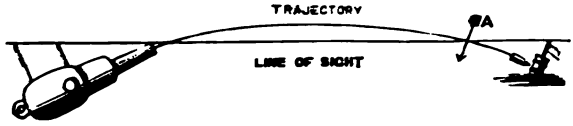
(3) *Axis of Trunnions.*—An imaginary line passing through the centre of the trunnions at right angles to the axis of the piece, C D.

(4) *Windage.*—The difference between the diameter of the bore and that of the projectile.

(5) *Trajectory.*—The curve described by the projectile in passing from the muzzle of the piece to the first point of impact.

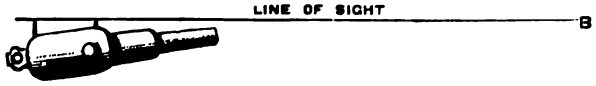
(6) *Range.*—The distance from the muzzle of the

piece to the intersection of the trajectory with the line of sight, A.

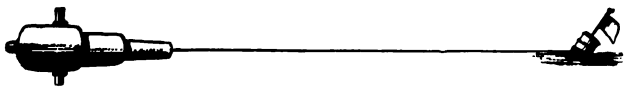


(Sights shown out of proportion better to illustrate it.)

(7) *Line of Sight.*—An imaginary line passing through the sights of the piece and the point (B) aimed at.

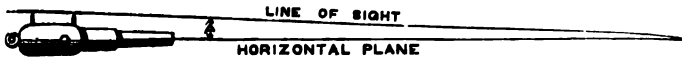


(8) *Line of Fire.*—An imaginary line joining the muzzle of the piece and the point aimed at.

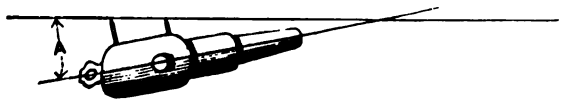


(9) *Plane of Sight.*—The vertical plane passing through the "line of sight."

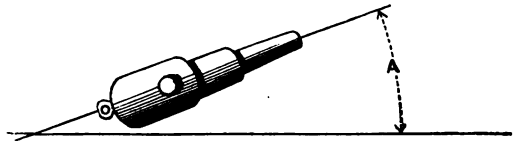
(10) *Angle of Sight.*—The angle which the line of sight makes with the horizontal plane, A.



(11) *Angle of Elevation.*—The angle (A) which the line of sight makes with the axis of the piece.



(12) *Quadrant Angle.*—The angle (A) which the axis of the piece when laid makes with the horizontal plane.



(13) *Line of Departure.*—The direction in which the projectile is moving on leaving the muzzle. (In other words, a tangent to the trajectory at the muzzle.)

(14) *Plane of Departure.*—The vertical plane passing through the line of departure.

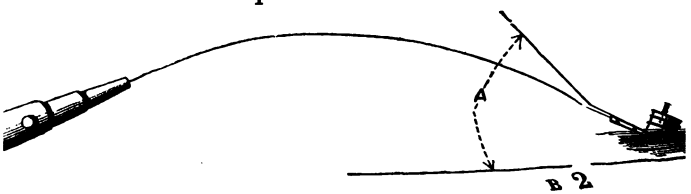
(15) *Angle of Departure.*—The angle which the horizontal plane makes with the line of departure.

N.B.—The excess of the angle of departure above the quadrant angle is called the "jump."

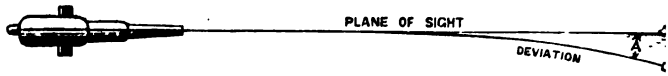
(16) *Angle of Projection.*—The angle between the line of departure and the line of sight.

N.B.—The difference between this and the angle of elevation is due to the "jump" (*vide* 11).

(17) *Angle of Descent.*—The angle (A) which a tangent to the trajectory at the point of impact makes with the horizontal plane.



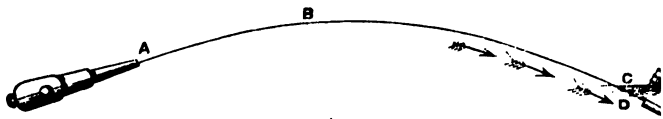
(18) *Lateral Deviation.*—The perpendicular distance of the point of impact right or left of the plane of sight, A.



(19) *Drift.*—The *constant* deflection of a projectile from the plane of departure due to the rotation imparted by the rifling of the piece (sometimes termed "derivation").

(20) *Point-blank.*—A gun is said to be laid "point-blank" when the line of sight is parallel to its axis. Point-blank range is the range due to the jump of the gun.

(21) *Muzzle Velocity.*—The velocity in feet per second of the projectile on leaving the piece, A.



Remaining Velocity.—The velocity of a projectile at any given point of its trajectory, B.

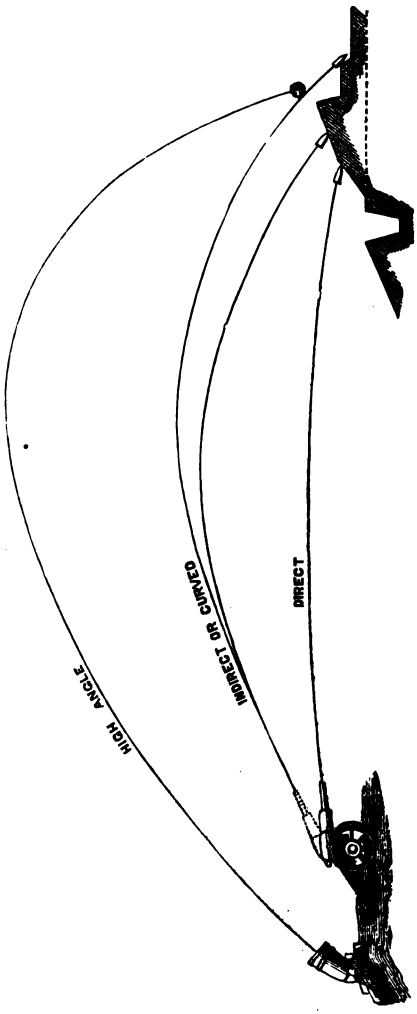
Striking Velocity.—The velocity of a projectile at point of impact, C.

Terminal Velocity.—The maximum velocity which it is possible for a projectile to acquire by falling through the air, D.

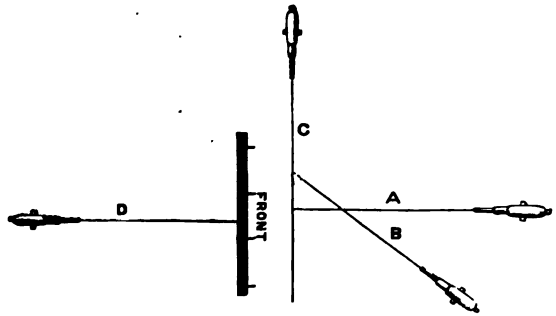
N.B.—After the projectile begins to descend its velocity is of course increased by the accelerating force of gravity.

Q.—Make a diagram showing the different natures of artillery fire with reference to the vertical and *horizontal* planes.

A.—*Vertical* plane (*see opposite page*).


VERTICAL PLANE.
HIGH ANGLE
INDIRECT OR CURVED
DIRECT

Horizontal plane.



A. Frontal. B. Oblique. C. Enfilade. D. Reverse.

Q.—What are the principal questions to be decided in the construction of ordnance?

A.—1. The best material for ordnance.
2. The best system of rifling.
3. Muzzle or breech-loading.
4. Proportion of weight to calibre.

Q.—Which service guns are still made of cast iron?

A.—The converted guns, which are of cast iron, strengthened by an internal tube of wrought iron.

Q.—What is bronze composed of, and what are its disadvantages?

A.—Copper 90 parts, tin 10 parts.

It is difficult to get these metals to mix thoroughly, and in the bore of a bronze gun the specks of tin are quite distinct; as tin melts at a lower temperature than copper these specks gradually disappear through the heat of the discharge, and the bore becomes honeycombed.

It is also very soft, and the bore becomes indented.

It is also non-elastic and very expensive.

Q.—Is there a gun now in the service made of *bronze?*

A.—*Yes; one* pattern of 7-pr.

Q.—What are the advantages of cast-iron?

A.—*None*, except that it is easily cast, and cheap.

Q.—What is wrought iron?

A.—Iron freed from much of its carbon by "puddling."

Q.—What are its advantages?

A.—It is capable of being hammered and rolled into any shape; it is hard and much more elastic than cast iron; it is not so brittle, and does not burst —with fair treatment—without giving notice. In rolling and drawing this metal a *fibre* is developed of which advantage is taken as follows: it is found that when struck in the direction of this fibre it offers a resistance one-third greater than when struck across the fibre. In making our guns therefore, we arrange the metal so that the strains of explosion may meet it in the direction of its fibre.

Q. What is the per-centage of carbon in (1) wrought iron and (2) steel?

A.—(1) From 0·1% to 0·3%.
(2) 0·3% to 2·0%.
According to Dr. Percy 0·5% to 0·65%.

Q.—What is the per-centage of carbon in cast iron?

A.—From 2% to 5% by weight of carbon, which exists in two states, either chemically combined with the iron or mechanically mixed with it.

Q.—Is any gun in the service made entirely of steel?

A.—Yes. The 7-pr. mountain gun.

Q.—What is steel?

A.—An alloy of iron cast while in a fluid state into a malleable ingot.

Q.—What are the disadvantages of steel?

A.—It has been found very difficult to cast heavy guns of this metal without *flaws*, and the expense of steel as compared with wrought iron has prevented very serious attempts to overcome this. It is brittle *and not* malleable, and is liable to burst explosively.

Q.—Why is steel used in the bores of the service heavy guns?

A.—Not for the purpose of giving strength, but because it offers a hard surface not easily affected by the corrosive action of the ignited gunpowder, also because of its great cohesion and elasticity. (It is nearly three times as elastic as wrought iron—30 to 12.)

Q.—Why is its elasticity an advantage?

A.—Because it permits of its being temporarily extended by the shock of discharge, but immediately regaining its original form and size.

Q.—Are there any means of toughening steel?

A.—Yes. It may be made much tougher and less brittle by bringing it to a white heat and cooling it gradually in a bath of oil.

Q.—Is it not found to answer well for armour-plates?

A.—Yes, combined with wrought iron. At Shoeburyness are plates of tough steel which have been fired at for experiment: instead of having penetrated the plate, as it would have done had it been made of iron, the projectile has only scooped a portion of the surface out, like butter, and turned off, leaving the plate practically uninjured.

Q.—Can bronze be hardened?

A.—Yes, by a mixture of phosphorus, the alloy being called phosphor-bronze.

Q.—For what is it used in our service?

A.—For the pipe-boxes of field artillery wheels. (In Austria a similar alloy, called bronze-steel, is used with great success in the manufacture of field guns.)

Q.—Define the terms:—(1) Malleability, (2) Elasticity, (3) Tenacity, (4) Toughness.

A.—(1) *Malleability* is the property of being permanently extended in all directions, by rolling, *pressing*, or hammering, without rupture.

(2) Elasticity is the property possessed by a metal of

resisting permanent deformation when subjected to a stress, and is measured by the ratio of stress to strain.

(3) *Tenacity* is the tension required to produce rupture.

(4) *Toughness* is having the quality of flexibility without brittleness, yielding to force without breaking.

Q.—What is the object of any system of rifling?

A.—The objects of rifling are three-fold.

(1) It increases the *accuracy.* In an S.B. you have an uncertain deviation depending upon the last bump of the projectile in the bore, the position of its centre of gravity, &c., and a high trajectory. By rifling you obtain a fixed and definite deviation to the right, which you can counteract by fixing the tangent scale at an angle to the left, and you also obtain a lower trajectory.

(2) It increases the *range.* As the atmospheric pressure increases as the square of the diameter, the range is increased by rifling, as you are enabled to fire a projectile much heavier than the S.B. and which at the same time exposes only about half the surface to the atmospheric resistance.

(3) You are enabled to fire a much heavier projectile out of the same gun, or the same weight of projectile out of a much heavier gun.

Q.—Give a familiar example of the latter (3).

A.—The 64-pr. R.M.L. converted gun of 58 cwt.

Before conversion this gun fired a projectile of 32 lbs. weight, with a charge of 8 lbs. of powder.

After conversion we were able to use a projectile weighing 64 lbs. with the same gun and charge of powder, giving us a greatly increased range with a much flatter trajectory.

Q.—Would the "muzzle velocity" and "pressure on the powder chamber" be greater in an S.B. than in an R.M.L. gun, charges and projectiles of the same weight being used with each?

A.—The muzzle velocity would be greater in the

S.B., because the projectile, having a greater diameter than the rifled one, would present a larger surface to the propelling action of the powder gas.

The pressure in powder chamber would be greater in the rifled gun, owing to the greater difficulty in starting the projectile, the greater amount of friction from the rifling, &c.

Q.—If the hind sights of an R.M.L. gun were perpendicular, to which side would you give deflection? And would you give the same amount of deflection at a long range as at a short one?

A.—To the left. You would increase it in proportion to the length of range.

N.B.—In our service it would be to the left, because the twist of rifling is right-handed, hence the drift or permanent deviation is to the right.

Q.—How many systems of rifling are there?

A.—Four.

Q.—Name them.

A.—(1) Breech-loaders with projectiles having soft metal coating or rings, larger in diameter than the calibre of the gun, and forced into the grooves by the discharge of the gun.

Example—The service Armstrong B.L. and the German system.

(2) Breech or muzzle-loaders, with hard projectiles depending for their rotation upon mechanical fit.

Example—Whitworth and Lancaster systems. Quite obsolete.

(3) Muzzle or breech-loaders with projectiles having a sabot attached to their base, which is expanded into the grooves on the discharge of the gun.

Example—The service 6·3″ howitzer and the new Armstrong B.L. guns.

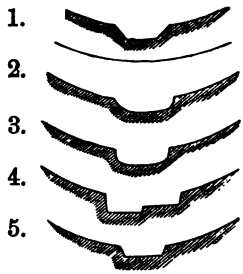
(4) Muzzle-loaders with projectiles having studs or ribs to fit the grooves.

Example—*Our* present R.M.L. guns.

Q.—Show by sketches the peculiarities of the grooves in each of the following modifications of No. 4 system of rifling :—

1. The French (7-pr.).
2. Modified French (9-pr. and 16-pr.).
3. Woolwich. 80-pr. upwards, &c.
4. Shunt. Obsolete (64-pr.).
5. Plain groove, (64-pr.).

A.—



Q.—Show by sketch a section of Armstrong rifling.

A.—

Q.—What is the plain groove?

A.—It is really the deep portion of the shunt.

Q.—Why is the 64-pr. converted gun rifled with the plain groove?

A.—To enable us to use up the large quantity of 64-pr. shunt ammunition remaining in the service.

Q.—What two incompatible qualities do we require from guns?

A.—The maximum of effect and the maximum lightness.

Q.—What does the first involve?

A.—The use of heavy shells with large bursting *charges* and high velocities.

Q.—How is the velocity obtained?

A.—By using large charges of powder.

Q.—What does this necessitate?

A.—The weight of gun, carriage, &c., must be proportionally great.

Q.—The second quality, i. e. lightness, is of great importance in field and siege artillery, and it is opposed to the use of heavy charges with heavy shells, &c.; what is therefore necessary?

A.—If a heavy charge is used, the shell must be light, and *vice-versâ*.

Q.—Do these considerations govern the proportion of weight to calibre?

A.—Yes. And hence the necessity for different calibres and the three natures of ordnance, viz. guns, howitzers, and mortars.

Q.—When is there less strain on a gun?

A.—The greater the number of grooves, the shallower they are and the less rapid their twist, and the more easily the projectile is started.

Q.—When must the twist be sharper?

A.—The longer the projectile, the less perfectly it is centred, the lower its muzzle velocity, the shorter the gun, and the longer the range at which it is intended to be used.

Q.—What is the cause of the drift or permanent deflection of a projectile fired from a rifled gun in the direction of its rotation?

A.—It is chiefly due to the fall of the projectile by gravity, causing the air to be more dense underneath it than at the sides and top, and thus forming a cushion on which it rolls.

Q.—What is meant by an uniform twist?

A.—Rifling the twist of which is uniform throughout the bore.

Q.—What guns are rifled with an uniform twist?

A.—*All guns up to* the 7" R.M.L. inclusive.

Q.—Why are the studs, on projectiles fired from guns having an increasing twist, of different sizes?

A.—The front row of studs on all projectiles fired from guns with an increasing twist are smaller, thus the projectile is more easily started and the friction less, the front row only acting upon it as it gets near the muzzle, giving it a stable axis before leaving the gun.

Q.—What guns have an "increasing twist"?

A.—The 8″ and upwards, inclusive.

Q.—Why are the studs on the 80-pr. projectile of different sizes, although the gun has an uniform twist?

A.—For manufacturing reasons, as it weakens the shell less, and putting the small studs in under hydraulic pressure does not strain it so much.

Q.—What advantages have B.L. over M.L. guns?

A.—Greater rapidity of fire.
Greater cover for the detachments.
Diminished windage.
Greater ease in loading, &c.

Q.—What on the other hand do the advocates of M.L. guns allege in favour of retaining their system?

A.—That it has been proved by actual experiment that M.L. guns can be fired even more rapidly than B.L.

That gas checks have practically abolished windage.

That with regard to cover for the detachments, if in the *open*, it is immaterial whether the loading is done at breech or muzzle; and if behind parapets, there is more than one system of making the gun recoil under cover, so as to be loaded with perfect safety to the men; and that steam and hydraulic gear, jointed rammers, overbank carriages, &c., enable *us to load* without exposing a man.

Q.—What discovery turned the scale in favour of breech-loading?

A.—The discovery of the advantages to be gained by chambering a gun, or "air-spacing" a cartridge.

Q.—What is meant by air-spacing a charge of powder?

A.—By air-spacing is meant making the diameter of the powder chamber greater than the diameter of the cartridge.

Q.—What is the effect upon the velocity imparted to the projectile, and the pressure upon the powder chamber of the gun, assuming same weight of charge employed?

A.—With *equal* charges the velocity is much less, while the pressure on the powder chamber is very greatly decreased.

Q.—Describe how air-spacing can be advantageously employed, and why.

A.—Air-spacing can be, and is, employed as above described, it having been found by experiment that if the *amount of charge* is increased at the same time as the *space occupied* per lb. of powder, a much higher velocity is obtained without appreciably increasing the pressure in the powder chamber.

Q.—How does this turn the scale in favour of B.L. guns?

A.—Because full advantage cannot be taken of chambering with M.L. guns, as, however much you increase the diameter of the powder chamber, you cannot, in loading from the muzzle, get a cartridge into it greater in diameter than the calibre of the gun. Collapsing cartridges were tried, intended to expand on ramming home, but, as might be supposed, they jammed and did not answer.

On the other hand, in loading from the breech you *can have your* chamber and cartridge of any size *you like without* difficulty.

Q.—Is there nothing else which tells in favour of breech-loading guns?

A.—Yes. The increasing use of slow-burning powder, which necessitates much greater length of bore. A breech-loading gun can be of any length without inconvenience, whereas of course if an M.L. gun is too long it is extremely inconvenient to load.

Q.—What other disadvantages have B.L. guns?

A.—They require a very expensive breech-closing arrangement.

In the old Armstrong B.L. guns the lead coating necessitates the use of a lubricant. And the absence of windage obliges us to use an expensive fuze, because of the detonating arrangement necessary to set it in action.

Q.—Are time fuzes with a detonating arrangement in the head ever used with M.L. guns?

A.—Yes. The 15 second B.L. fuze is used with heavy guns when gas checks are fired, as the gas check often so effectually seals the windage as to prevent the ignition of the priming in an ordinary fuze.

Q.—How is the metal of a gun arranged?

A.—It is so arranged that it is thickest where the strain is greatest, namely, round the seat of explosion. This accounts for the conical shape of our guns.

Q.—What is the difference in diameter between the breech and muzzle called?

A.—The "dispart."

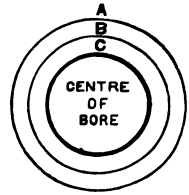
Q.—Is it possible to have too great a thickness of metal?

A.—Yes. That part of the metal next the charge has to do more "work" than the part further away, and we might have the metal so thick that the part *next the charge* would be ruptured before the part

most distant had done any work at all. In this case, it will be seen at a glance, we should have made our guns unwieldy without gaining any strength in return.

Q.—What is the formula for this?

A.—As W (work) at B : W at A :: AC^2 : BC^2.



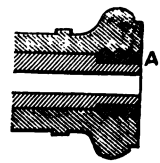
The rule (as above) as to the work done at any two points in the metal of a gun, is, that it is in the inverse ratio of the squares of the distances of those points from the bore.

Q.—What determines the angle at which tangent scales are set to the left to counteract the drift?

A.—Actual experiment at Shoeburyness.

Q.—Describe the mode of conversion of an M.L.R. gun from an S.B.

A.—The cast-iron gun is bored out to a diameter of 10½ inches; a wrought-iron tube is then inserted, made slightly smaller than the bore of the casing, so as to be pushed home without much difficulty. It is kept in by a cast-iron collar fitting over a shoulder on the muzzle end of the tube and screwed into the casing thus, A.



The tube is kept from turning round by a screw through the casing underneath the gun a few inches in front of the trunnions.

Q.—Describe the wrought-iron tube.

A.—It consists of five coils made in the usual way. They are faced and recessed at their ends respectively, the spigot of one coil fitting into the faucet of the other. The tube is double for 32 inches of its length from the breech end, the outer portion being *called the B tube*; round the exterior of the inner *portion is turned* a spiral groove, communicating by

the star grooves with the gas escape ("tell-tale") hole in the breech of the gun. The breech end of the tube is closed by a wrought-iron cup screwed in. It is rifled with three plain grooves.

Q.—How is the gun tested?

A.—It is proved with two rounds of 1¼ the service charge, and the service projectile, and the expansion caused by proof must not exceed certain limits. After proof the gun is gauged, examined by gutta-percha casts being taken, and again tested with water pressure of 120 lbs. on the square inch to see that the breech is still perfectly tight.

Q.—Name the S.B. guns that have been converted into R.M.L. guns, and the guns into which they have been converted.

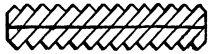
A.—The 32-pr. of 58 cwt. into the 64-pr. of 58 cwt. The 8″ shell-gun of 65 cwt. into the 64-pr. of 71 cwt. The 68-pr. of 95 cwt. into the 80-pr. of 5 tons.

Q.—Is the mode of conversion the same in all?

A.—Yes.

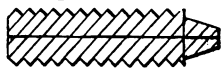
Q.—How are they vented?

A.—All converted guns, and all other guns when *re-vented*, have "through-vents," i. e. the vents are cylindrical throughout and turned with a thread from end to end, thus;



Q.—What is a cone vent?

A.—A vent used with all heavy R.M.L. guns with the above exceptions. It is cylindrical for a certain distance of its length, terminating in a cone, the cylindrical portion only being turned with a thread, thus;



Q.—Of what metal are vents made?

A.—Of hardened copper.

Q.—What guns are top vented?

A.—*All heavy* guns up to the 9″ inclusive.

Q.—What is the position of the vent in 10″ guns and upwards?

A.—It is placed for convenience at the side, and at an angle of 45° from the perpendicular.

Q.—What exception is there to this rule?

A.—The 81-ton gun, which has an axial vent, i. e. the vent is in the breech of the gun, coincident with the axis of the piece.

Q.—What is the relative position of the vent, with regard to the bottom of the bore, in heavy guns?

A.—In the heavier natures it is placed so as to strike a point corresponding with a point $\frac{4}{10}$ of its length from the breech end of a battering charge.

Q.—How often are guns examined?

A.—9″ and upwards after every 50 rounds, 7″ R.M.L. and R.B.L., 8″ and 64-pr. R.M.L. after every 100 rounds, and 64 B.L. and smaller guns after every 150 rounds.

Q.—How are B.L. guns vented?

A.—In Armstrong's B.L. guns the vent is in the vent-piece, and it is right-angled. It is only copper part of the way down, and to assist the flash in passing from the tube to the cartridge a "primer" is used.

Q.—Give shortly the notable features in the construction of Armstrong's B.L. guns.

A.—They consist of an inner barrel or A tube, a forged breech-piece, a forged trunnion ring, and one or more coils varying according to the size of the gun.

Q.—Give the names of the breech fittings.

A.—(1) The vent-piece: consisting of,

Body.
Vent-bush, copper, 2 parts.
Vent-piece copper ring.
Cross-head and shackles.

(2) Breech-screw.
(3) Indicator ring.
(4) Tappet ring.
(5) Lever and keep pins.

Q.—Of what metal are vent-pieces usually made?

A.—Various metals have been employed in their manufacture, such as steel, Swedish iron, Marshall's refined iron, &c. The name of the material of which they are made is, however, always stamped on the side or back.

Q.—If you met, at an out station, with a vent-piece having no "projection" on back, would you use it?

A.—Under no circumstances.

Q.—How are B.L. guns proved?

A.—Without their breech-closing apparatus (spare ones being used) by firing 6 rounds of 1½ times the service charge and a service shot.

Q.—What is the Armstrong system of rifling called?

A.—Polygroove.

Q.—At what angle are the sights set in B.L. guns?

A.—In the Armstrong B.L. and the service R.M.L. converted guns the sights are set at an angle to the left of 2° 16′.

Q.—How do the Armstrong and Fraser systems differ in the construction of heavy R.M.L. ordnance?

A.—The Fraser system differs from that of Sir W. Armstrong in having a *small number* of *heavy* coils, a *coiled* breech-piece, and a *coiled* trunnion ring shrunk on in conjunction with two other coils.

Instead of a *large* number of *light* coils, a *forged* breech-piece, and a trunnion ring shrunk on separately.

Q.—Describe as briefly as possible the parts of a 10″ R.M.L. gun.

A.—It consists of,

(1) A tube (toughened steel).
(2) B tube.
(3) 1 B coil (ordinary coil).
(4) Coiled breech-piece.
(5) C coil (or jacket).
(6) Cascable.

Q.—Describe briefly the mode of building up the gun.

A.—The B tube is placed on a grating and heated for about two hours, by means of a wood fire, until it is sufficiently expanded to drop easily over the muzzle end of the A tube (or steel barrel), which is placed upright in a pit ready to receive it. The B tube is then raised and dropped over the steel barrel by an over-head travelling crane. The 1 B coil is then shrunk on. The remaining parts are then shrunk on in succession.

Q.—When are the guns rifled?

A.—Before the jacket is shrunk on, to save the labour of lifting so much weight from one machine to another.

Q.—When is the cascable screwed in?

A.—Before the C coil or jacket is shrunk on; the cascable thus gains the advantage of the compression.

Q.—How does the steel tube in a Fraser gun differ from that in an Armstrong gun?

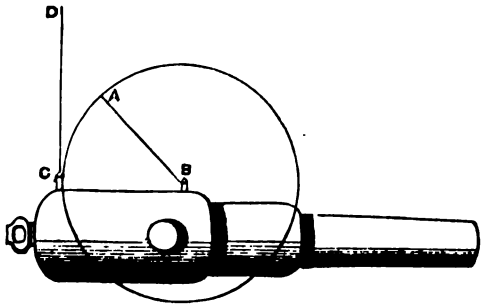
A.—The breech end is thicker to compensate for the breech-piece not being forged.

Q.—How are the divisions or degrees upon the tangent scale obtained?

A.—The radius between the sights divided by 57 gives one degree upon the tangent scale.

Q.—Illustrate this by sketch.

A.—



Divide the radius A B (in inches) by 57, and set off

equal divisions on the tangent C D. Each division will represent 1°.

Q.—What is the clearance angle of converted guns?
A.—5°.

Q.—After 5° are the divisions on the tangent scale of a converted gun longer?
A.—Yes. Because then the muzzle or fore sight has to be used, and of course the radius is much longer between it and the back sight, than between the trunnion sight and the back sight.

Q.—What are the lines on a heavy gun intended to denote?
A.—The lines on the upper surface mark the end of the bore and the commencement of the rifling. The mark on the chase is the "half-weight mark." The horizontal mark on the right trunnion shows the axis of the piece, and the vertical line is at right angles to it. They can be used in giving quadrant elevation.

Q.—What are the ingredients of gunpowder?
A.—Saltpetre 75 parts, charcoal 15 parts, and sulphur 10 parts.

Q.—Upon what does it depend for its effect?
A.—Upon the elastic force developed by the sudden evolution of a large volume of gas.

Q.—From what is this gas derived?
A.—From the combustion of the carbon (charcoal) in the oxygen contained in the saltpetre.

Q.—What is the action of the sulphur?
A.—It serves to lower the point of ignition of the powder, and to increase the temperature and rapidity of its combustion, thus increasing the volume of the gases by expansion.

Q.—What space would it occupy if it could be fully expanded at the moment of explosion?
A.—A space about 2000 times as great as that *occupied by the* powder from which it was resolved.

Q.—What is the temperature of the explosion?
A.—About 2200° C. (4000° Fahr.).

Q.—What are the disadvantages of gunpowder?
A.—The chief disadvantages are the smoke and dirt attending its explosion.

Q.—What are its great advantages (from a gunnery point of view) over other explosives?
A.—The comparative slowness of its combustion, whereby the strain on the gun is reduced. Also the power we have (by modifying the density, size of grain, &c.) of regulating, to a great extent, the rapidity of this combustion.

Q.—What is one of the greatest difficulties of the powder-maker in his endeavours to produce a uniform powder?
A.—The variability of the charcoal. It varies according to the climate in which the wood is grown, and even to the time of year in which it is cut. It is also greatly affected in manufacture by any variableness in the intensity of the heat to which it is subjected.

Q.—Are density and hardness synonymous terms when used with reference to powder?
A.—No. Hardness is independent of density. Its effect is to retard the ignition of the powder.

Q.—How is it produced?
A.—By pressing the powder when moist.

Q.—What is the effect of moisture in powder?
A.—It reduces the temperature of the explosion by the steam developed, and thus reduces both the pressure and the velocity.

Q.—How was this proved by experiment?
A.—By experiment with an 8″ R.M.L. gun firing a shot of 180 lbs. with a charge of 35 lbs. of powder, an increase of 0·7 % of moisture decreased the M.V. *by 50 feet* per second, and decreased the pressure by *2·47 tons.*

Q.—What is the advantage of using a large-grain powder?

A.—The pressure is more uniform.

Q.—Do not the grains take longer to burn?

A.—Yes. Each *individual* grain takes longer to burn, but as the interstices between the grains increase with their size, there is more space for the flame to pass between them, and the *whole charge* is thus more rapidly ignited.

Q.—Why is there more strain on the gun from using a small-grained powder?

A.—With a small-grained powder, a large volume of gas is generated at the point of ignition of the charge. This rushes violently through the interstices of the charge, and between it and the bore, and gives rise to what is called a "wave action," and *intense local pressures.*

Q.—Does the point of ignition of the charge, with medium-grained powder, affect the velocity?

A.—Yes. It has been found by experiment that the highest velocity is obtained by igniting the cartridge at about $\frac{4}{10}$ of its length from the rear.

Q.—In determining relatively (in any particular gun) amount of charge, size and hardness of grain, calibre, length of gun, &c., what would be a theoretically perfect result?

A.—That they should be so relatively proportioned that the last grain of powder would be burnt as the projectile was leaving the muzzle.

Q.—What is the difference between L.G. and R.L.G. powder?

A.—L.G. powder is dull and dirty-looking, R.L.G. is larger in grain, clean, and highly glazed.

Q.—With what guns is R.L.G^2. used?

A.—It may be used instead of L.G. or R.L.G. for all R.B.L. guns up to the 40-pr. inclusive, for the 6 lb., 8 lb., and 10 lb. charges for the 64-pr. R.M.L. *guns, and for* all S.B. guns.

Q.—In using it for the exceptional heavy charge for the 64-pr. of 64 cwt., mark III., with battering shell, would you use the same quantity of R.L.G². as R.L.G.?

A.—No. You would use 11 lbs. of R.L.G². instead of 12 lbs. R.L.G.

Q.—Will P. powder be used in future for the "full" charges of certain guns, instead of L.G. and R.L.G.?

A.—Yes. For the undermentioned:—

9″ R.M.L.	33 lbs.	P. instead of	30 lbs.	R.L.G.	
8″ „	21 „	„	20 „	or L.G.	
7″ „	17 „	„	14 „	„	
80-pr. „	12 „	„	10 „	„	

The existing stock of filled cartridges will be used up, and R.L.G. and L.G. will still be issued for these charges when P. is not available.

Q.—Does the use of P. powder necessitate any alteration in the cartridge bags?

A.—Only in the case of the 7″ R.M.L.; when using P. an extra braid (hoop) is required at the top of cartridge.

Q.—For what other guns is P. powder used?

A.—For the battering charges of all R.M.L. from 7″ to 12″ inclusive.

Q.—For what guns is P². used?

A.—For 12·5″ guns and upwards, and for 140 lb. charge for 12″ guns of 35 tons, and for the 114 lb. and 76 lb. charges for 12″ guns of 25 tons.

Q.—What is prismatic powder used for?

A.—It is at present experimental.

Q.—What is cubical powder used for?

A.—For the charges for the 80-ton and 38-ton guns, and for the new Armstrong B.L.

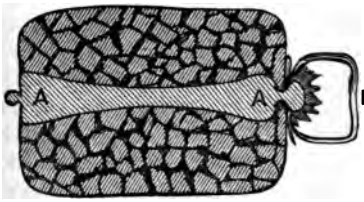
Q.—How are the cartridges for the 12·5″ gun made up?

A.—*The 160* lb. charge for the 12·5″ gun is

de up in two cartridges of 80 lbs. each, in bags of
. 1 class silk cloth, with beckets and sticks.

Q.—Show by sketch how the stick is used.
A.—The stick is used to prevent the alteration of
ə length of the cartridge in ramming home by

A. The stick.



B. The becket.

ydraulic pressure, otherwise it would expand and
ll the chamber, thus reducing the "air-space."

Q.—Of what material are the cartridge bags for
.M.L. guns made?
A.—Of silk cloth, hooped with the same, and
ıoked with silk twist.
The existing stock of serge bags may be used up
ır charges up to 85 lbs.

Q.—Is there any exception to this rule?
A.—Yes. The cartridge bag for the 4 oz. charge
ır the 7-pr., which is made of red shalloon.

Q.—What is the charge for the 7-pr. of 400 lbs.?
A.—1 lb. 8 oz.

Q.—Of what use are beckets, and from what weight
charge upwards are they used?
A.—Beckets are to facilitate loading, to enable us
ore easily to handle and withdraw the cartridge
om the case. They are used for 20 lb. charges
d upwards.

Q.—How is loose powder packed?

A.—In wooden barrels, hooped with copper and ash hoops.

Q.—Name the different sizes, and the quantity held by each.

A.—"Whole," "half," and "quarter" barrels. The whole barrel will contain 125 lbs. of P. and P^{a}. powder, 120 lbs. of R.L.G^{a}., and 100 lbs. of all other natures.

Q.—How are filled cartridges stored (up to 80-pr. R.M.L. and 7″ R.B.L. inclusive)?

A.—In metal-lined cases, the lids being carefully luted (the edges greased) before screwing down, to exclude all moisture.

Q.—What are metal-lined cases?

A.—They are rectangular cases of deal, the corners of oak, and the cleats of ash, lined with tinned copper. The square lid, which is screwed down by two gun-metal bolts, covers a circular opening which is closed by a bung of tinned copper. The bung is luted in its place when the case is full.

Q.—Of what sizes are they?

A.—Three: whole, half, and quarter.

Q.—How are cartridges for guns of a heavier nature stored?

A.—Each cartridge is placed in a separate zinc cylinder, with the nature of gun, charge, &c., stamped on the lid.

Q.—How are they stacked?

A.—In tiers—

7″, 5 deep.
9″ and 10″, 4 deep.
11″ and upwards, 3 deep.

Q.—Can 7″ and 9″ cartridges be stored in metal-lined cases?

A.—*Yes.* The "whole" size will take the 9″ *cartridges,* except when filled with P. powder.

Metal-lined cases are to be preferred where injury from damp is to be apprehended.

Q.—How are cartridges marked?

A.—Outside, with the nature of gun, the charge, and the description of powder.

Q.—Are B.L. cartridges now issued with lubricators attached?

A.—No. They have a socket choked into the top of the cartridge, into which the lubricator screws, and the lubricator is only attached just before issue from the expense cartridge store.

Q.—Describe the making up of an ordinary M.L. cartridge?

A.—The powder is carefully weighed and poured in, the cartridge is then choked and hooped, i. e. the hoops are drawn taut and fastened with a single bend over the loop. The superfluous choke is cut off, and the cartridge gauged for length and diameter.

Q.—Of what material are B.L. cartridge bags made?

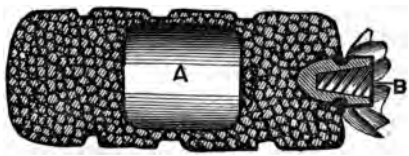
A.—Of serge, hooped with blue worsted braid, and choked with thread.

Q.—In what does the making up of an Armstrong B.L. cartridge differ from the above?

A.—*Half* the charge is weighed and poured in, the paper cylinder is then put in, and the second half of the charge poured in. The lubricator socket is inserted in the mouth of the bag and fastened in choking.

Q.—Show, by sketching B.L. cartridge in section, the position of cylinder and socket.

A.—



A is the cylinder.

B is the socket.

Q.—Why is the paper cylinder used?

A.—Because since the guns were first constructed the charge has been reduced, and the cylinder is used to bring the cartridge up to the length of the service cartridge.

Q.—What precaution is taken to prevent shrapnel cartridges from becoming injured by stamping, &c.?

A.—They are periodically examined: if found to be leaking, &c., they are pulled by hand pressure.

Q.—What is a nurrenator?

A.—A case of tinned iron filled with linseed oil and tallow upon shock of discharge is bursts and lubricates the grooves of the rifling in its passage down the bore.

Q.—What precaution do you take to secure uniform results from your shooting if you find that the powder you are using is of different brands?

A.—Carefully mix the powder before making it up into cartridges.

Q.—What is the difference in manufacture between a Palliser shell and a common shell?

A.—A Palliser shell is cast point downwards, as that is required to be the densest part. The point of the shell is cast in a metal mould, and the body in sand; thus the point is extremely hard, being "chilled."

Common shell is cast base downwards, as that is required to be the strongest part, to withstand the shock of discharge, &c.

Q.—How are the studs put in?

A.—The holes in which they go are under-cut; the studs are placed in and pressed home by heavy hydraulic machinery; this expands the soft metal stud into the under-cut rim.

Q.—Describe the construction of a 64-pr. shrapnel shell.

A.—A shrapnel shell consists of a cast-iron body with a chamber in the base; it is weakened internally

by six longitudinal grooves, forming lines of least resistance. The chamber contains a tin cup to hold the bursting charge. Over that is placed an iron disc or diaphragm pierced with a hole in the centre, tapped with a thread; into this is screwed a wrought-iron tube, over which is fitted a wooden cylinder. The inside of the body is lined with brown paper. It is filled up with bullets of lead hardened in antimony, and hot resin is poured in to fill up the interstices; over this is fitted a wad of felt or kamptulicon. The head is of elm, ogival in form; it has a hole in the centre, in which is placed a gun-metal fuze socket, the bottom of which fits into the top of the wrought-iron tube, and it is tapped with a thread to receive the primer, which screws into it. The head is covered with a thin shell of Bessemer metal attached to the body by steel rivets and solder.

Q.—What is a case shot?

A.—A tin or tinned iron case, lined with segments of iron, and containing sand shot packed in clay and sand.

Q.—What difference is there between case shot for M.L. and B.L. guns?

A.—B.L. case shot have rows of studs round the base, to prevent the shot being pushed past the chamber in ramming home.

Q.—What is the peculiar feature of 7″ case?

A.—It is interchangeable for 7″ R.B.L. and 7″ R.M.L. guns, having three studs, which fit the grooves when used with the latter gun.

Q.—What is segment shell?

A.—A very thin cylindro-conoidal shell, lined with cast-iron segments built up in layers having a cylindrical powder chamber in the centre.

Q.—What is common shell?

A.—A cylindro-conoidal shell of cast iron, the *hollow centre* forming the chamber which contains

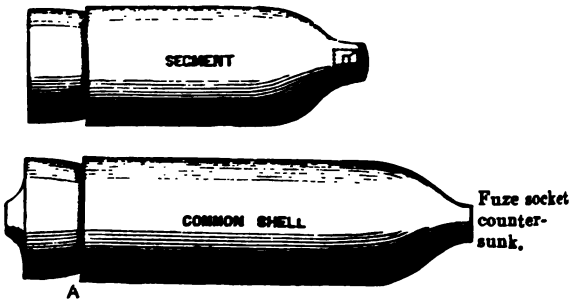
the bursting charge. This chamber is lacquered to protect the latter.

Q.—What is the average length of common shell?
A.—Generally about 2½ calibres.

Q.—How can you distinguish B.L. common shell from segment?

A.—It is longer, and has a projection on the base. Segment shell is shorter, has the base smooth, with a wide rim of lead, and has the fuze socket flush instead of countersunk.

Q.—Show each shell in a rough sketch.
A.—



Q.—What is the object of having the cannelure or channel, marked A in the above sketch, turned round the exterior of lead-coated projectiles?

A.—To take any strippings of lead which would otherwise cause a jam in the bore.

Q.—What are adapters, and why are they used with certain B.L. shells?

A.—They are brass or gun-metal sockets, tapped interiorly to take the general service plug, and exteriorly to fit the Moorsom gauge. They are used with 7″ R.B.L. shells, &c., having the old Moorsom gauge, to enable us to use the fuzes, &c., of general *service gauge.*

Q.—What is the battering shell, and with what gun is it used?

A.—It is a shell similar in construction to a Palliser shell, and is used with the 64-pr. built-up gun of 64 cwt., mark III.

Q.—What is its weight?

A.—90 lbs.

Q.—What is it used for?

A.—Against masonry.

Q.—With what fuze?

A.—The delay-action fuze.

Q.—What is solid shot from B.L. guns used for?

A.—For practice only.

Q.—What may common shell be used for?

A.—(1) To destroy the "personnel" and "matériel" of the enemy. (2) To destroy earthworks, buildings, &c.

Q.—What fuze would you use with common shell against wooden or unarmoured ships?

A.—Pettman's general service percussion fuze.

Q.—In using common shell against troops in the open, where would you burst them to obtain the maximum effect?

A.—Close up to the troops, or, if the latter are in column or other deep formation, on the head of the column.

Q.—Also against troops behind cover?

A.—The shell should be burst on the crest of the parapet or other covering obstacle.

Q.—Also against guns, limbers, &c.?

A.—Endeavours should be made to obtain direct hits.

Q.—On what does common shell depend for its effect when employed for the destruction of earthworks, magazines, buildings, &c.?

A.—On its striking velocity (and consequent penetration), combined with the explosive force of its *bursting charge*.

Q.—When would time fuzes be used with common shell?

A.—Only in very exceptional circumstances, such as when the ground in front of the enemy is very soft, and prevents the fuzes from acting or smothers the bursts, or if the troops are in such a position that the splinters of shells burst on graze pass over their heads.

Q.—Will common shell burst on impact when not fuzed?

A.—It has been found by experiment that common shells when fired directly into masonry explode on impact even when not fuzed.

Q.—How would you proceed to destroy a wall, &c., of masonry by direct fire, by *demolition*?

A.—The shells should be distributed over the whole or the greater part of the surface of the wall or building to be destroyed.

Q.—In what respect does breaching differ from this?

A.—In breaching, if circumstances permit, a horizontal cut, the width of the proposed breach, is formed at about one-third the height of the wall from the bottom. As soon as the wall has been cut through, vertical cuts from the extremities of the horizontal cut to the top of the wall are made to bring it down.

Q.—Why is breaching preferable to demolition?

A.—Because demolition involves a much greater expenditure of ammunition.

Q.—How is the maximum effect obtained in using common shell to destroy magazines, &c.?

A.—By firing at such a high angle as shall prevent ricochet (20° and upwards), and delaying the bursts of shells until they have obtained their full penetration.

Q.—How is this secured?

A.—By using delay-action percussion fuzes, or *time fuzes* bored long so as to burst the shells from *one to two seconds* after impact.

Q.—What is case shot used for?
A.—Against troops in the open, boats, &c.

Q.—Up to what ranges?
A.—Up to about 600 yards with field guns, and up to about 1000 yards with heavy guns.

Q.—What ground is most favourable for its use?
A.—Hard ground or water.

Q.—For what is shrapnel shell used?
A.—Against troops, men at guns, on decks and in rigging of ships, in boats, &c., when beyond case shot range.

Q.—Upon what does it depend for its effect?
A.—Upon the striking velocity of the balls and splinters disengaged from the shell on bursting.

Q.—What is the object of the bursting charge in shrapnel shell?
A.—It should not be more than sufficient to open it, or the balls will be dispersed to too great an extent.

Q.—With field artillery shrapnel at medium ranges, what is the angle of the cone of dispersion?
A.—Angle of cone of dispersion = 8°.

Q.—What front would a shell bursting 100 yards in front of a line of troops cover?
A.—Rule: Sine of 8°, i. e. 0·139, × distance in yards of burst from object = lateral spread of bullets.

$$\therefore 0{\cdot}139 \times 100 = 13{\cdot}900 = 13{\cdot}9 \text{ yards};$$

or say 14 yards.

Q.—What is about the maximum effective range of field shrapnel?
A.—*About 4000* yards.

Q.—How far in front of the object would you try to burst your shrapnel at (1) 1000 yards range; (2) 2000; (3) 3000?

A.—(1) 100 yards short.
(2) 80 " "
(3) 60 " "

Q.—Suppose you wished to use shrapnel at very short ranges, case shot not being available, would it have the same effect?

A.—Yes. You would reverse it and use without fuze and with the plug removed (that is to say, you would load with the point of the shell next the powder charge). Used thus it has the effect of case shot, and is very effective at short ranges.

Q.—What fuzes are used with shrapnel shell?

A.—The 5, 9, and 15 second time fuzes.

Q.—For what purpose are Palliser shell used?

A.—For penetrating armour plates.

Q.—When loaded, what explodes the bursting charge?

A.—There are two theories:—

1st. That the intense heat generated by the passage of the shell through the metal plate is sufficient to ignite the bursting charge.

2nd. That upon shock of discharge the bursting charge sets back into the base of the shell, forming a hard cake, which upon shock of impact is driven forward into the head of the shell with such force as to ignite the powder.

Q.—Roughly, what depth of iron can be penetrated, at 200 yards range, in relation to calibre of the gun?

A.—Calibre + 2 inches. Thus a 10″ shell at 200 yards would penetrate 12 inches of armour. (10 + 2 = 12).

Q.—*Bags* for bursting charges are used with

certain guns; name them and for what purpose used.

A.—With 64-pr. common shell and upwards.

To guard against friction between powder and interior of shell, and thus reduce the chance of "prematures."

Q.—Does the introduction of the bag occasion blind shell, owing to the flash from percussion fuze not penetrating to the bursting charge?

A.—Yes. The choke, although supposed to be poked in out of the way, is often under the fuze-hole, and prevents the flash penetrating as described in the question.

To obviate this a primer has been introduced for use with 64-pr. and 80-pr. common shell.

Q.—Describe it.

A.—It is a red shalloon bag containing 7 drms. of fine-grain powder.

Q.—How is it used?

A.—It is inserted in the shell before screwing in the percussion fuze, and serves to carry the flash to the bursting charge.

Q.—Describe the process of filling a Palliser shell.

A.—The shell is up-ended and the screw-plug removed. It is then carefully scraped out with a copper scraper, care being taken not to disturb the lacquer. The serge bag is put in, being pushed in with the filling rod, the mouth being kept from slipping in; the tunnel is then inserted, and the powder carefully poured in, being pressed down or "tamped" with the filling rod so as thoroughly to fill the chamber. When full, the bag is choked, the choke (the superfluous part having been cut off) poked in, and the screw-plug replaced. The shell is marked "filled."

Q.—How can you distinguish Palliser shell from Palliser *shot?*

A.—*By their* points, which are painted white.

Q.—Are not 64-pr. and 80-pr. guns the calibre?

A.—Yes.

Q.—How can you tell an 80-pr. shell from a (irrespective of difference of length)?

A.—A 64-pr. shell has three rows of studs, an only two.

Q.—Are the projectiles interchangeable emergency?

A.—Case shot is the same for both guns marked "64-pr. and 80-pr."—64-pr. shell co used in the 80-pr. gun, but not 80-pr. shell i 64-pr.

Q.—Why could not you use 80-pr. shell i 64-pr.?

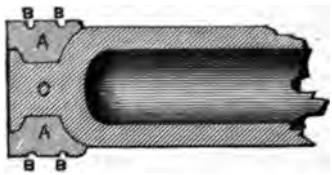
A.—Because the 80-pr. is rifled on the *W* system, and the studs on its shell would l large for the "plain grooves" of the 64-pr.

Q.—Describe the means used for giving ro to the projectile in the new Armstrong B.L. g

A.—The projectile is centred and the nec rotation imparted by means of a copper dr ring, attached to the base of the shell. This the rifling, and at the same time seals the winc

Q.—Sketch a rough section of shell, showin the driving-ring is attached.

A.—



A. A. The copper driving-ring.
B. B. B. B. The cannelures.
C. The stem on the base of the shell to which it is attac

The ring is kept from revolving by being

into sharp flutings cut in the base of the shell radiating from the centre.

Q.—What are gas checks?

A.—Saucer-shaped discs of copper attached to the base of a projectile.

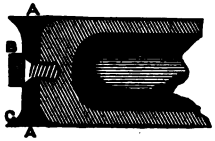
Q.—For what purpose are they used?

A.—To prevent guttering and scoring of the bore, by sealing the windage and preventing the rush of powder gas between the projectile and the bore.

By preventing the escape of gas greater velocity is also obtained, as none of the force of explosion is wasted.

Q.—Sketch a gas check attached to base of shell (in section), and explain how it acts.

A.—



A. A. Gas check.

B. Screw plug by which it is attached to the shell.

C. Flange.

By shock of discharge the flange is expanded, fitting the bore and grooves tightly, and thus sealing the windage.

Q.—Are not gas checks also used as a means of imparting rotation to the projectile?

A.—Yes. As in the 6·3″ howitzer. The gas check has radial projections, which are forced by the shock of discharge into corresponding grooves in the base of the shell; the flange is at the same time expanded, "taking" the grooves and thus imparting rotation to the projectile.

Q.—What is the rifling of the 6·3″ howitzer?

A.—Polygroove.

Q.—How are projectiles fitted with gas checks to be stored?

A.—*Resting* on their bases, supported each side of

the plug by battens (9″ × 1″ × 1″) to keep the plug and gas check clear of the ground.

Q.—How are they raised from the magazine floor to the gun floor?

A.—By means of a small winch, chain gear, and clips.

Q.—Can 9″ common shell be used with gas check?

A.—The old patterns, marks I. to V. inclusive, cannot. Mark VI. can be used with gas check and battering charge, being strengthened by having the walls thicker and two strengthening bands round it. Its capacity for bursting charge is of course decreased; it only holds 13 lbs. 14 oz. instead of 19 lbs.

Q.—What does the formula $\frac{Wv^2}{2g2240}$ mean?

A.—W = weight of projectile.
v = velocity of projectile in feet per second.
g = the force of gravity (i. e. 32·2).
2240 = the number of lbs. in a ton.
It is used to calculate the energy of a projectile.

Q.—Calculate the energy of a 10″ projectile, supposing it to havea n M.V. of 1800 feet per second.

A.—

$$W = 400 \text{ lbs.} \quad v = 1800. \quad g = 32{\cdot}2.$$

$$\frac{400 \times 1800^2}{32{\cdot}2 \times 2 \times 2240} = \frac{400 \times 3240000}{64{\cdot}4 \times 2240} = \frac{1296000000}{144256} = 8984{\cdot}02$$

Therefore 8984·02 = total energy of projectile in foot-tons.

If energy per inch of shot's circumference is required, then—

$$\frac{8984{\cdot}02}{10 \times 3{\cdot}1416} = \text{Ans.}$$

Q.—What are star shells?

A.—The 7-pr. star shell consists of a thin iron shell somewhat similar in construction to a shrapnel, with a wooden top covered with tin, and having a socket for the wood time fuze. It contains 13

magnesium stars, burning about 14 seconds; a small burster (about half a drachm) is placed under the diaphragm, and connected with quick match priming with the stars, which are thus ignited and projected out of the shell when the fuze acts.

Q.—What are the great desiderata in the material for shell for penetrating armour?

A.—Great hardness of the point without brittleness, so as to ensure the penetration of the iron armour upon impact.

Q.—How many descriptions of fuzes are there in the service?

A.—Two, viz. time and percussion.

Q.—Of what material are percussion fuzes made?

A.—Metal.

Q.—Of what material are time fuzes made?

A.—Wood, viz. beech-wood, which before using is "desiccated" and thoroughly seasoned.

Q.—What is fuze composition?

A.—It is a composition which burns at a regular rate.

Q.—What is the rate of burning of mealed powder?

A.—One inch in $2\frac{1}{2}$ seconds.

Q.—What is the rate of burning of fuze composition?

A.—Ordinary fuze composition burns 1 inch in 5 seconds. The composition used in the 15 second fuze burns 1 inch in $7\frac{1}{2}$ seconds, and that in the 30 second fuze burns 1 inch in 10 seconds.

Q.—Describe shortly, without details of construction, each time fuze.

A.—The 5 second fuze is driven with 2 inches of mealed powder; it is graduated in half and quarter *seconds of time* (or tenths and half-tenths of inches);

it burns 5 seconds at rest. It can be used up to about 1700 yards.

It is for use with shrapnel shell.

It is painted *red and drab.*

Nine-second. This fuze, though called a 9 second fuze, contains 2 inches of fuze composition, which burns 10 seconds at rest. It is marked on two sides in even and odd numbers, representing half-seconds of time.

It can be used with an R.M.L. shell up to about 3100 yards.

It is painted *black and drab.*

Fifteen-second. This fuze contains 2 inches of fuze composition, which burns 15 seconds when at rest; it will eventually supersede the 5 second and 9 second fuze, and can be used with an R.M.L. shell up to about 4000 yards. It is marked spirally, and is graduated to half and quarter seconds.

It is painted *black and drab.*

Twenty-second. This fuze is used for common shell. It has 4 inches of fuze composition, which burns 20 seconds when at rest.

It has no powder channels, and only the last 2 inches of composition are marked in a spiral direction, the numbers representing even half-seconds; thus, 20, 22, 24, and so on.

It is painted *black and drab.*

Thirty-second. This fuze can be used with R.M.L. common shell. It contains 3 inches of composition, burning 30 seconds when at rest.

It is marked spirally round the fuze in half and quarter seconds.

It is not prepared for less than 15 seconds, the marking commencing at 30. It is painted *black and drab.*

Q.—Describe the construction of a 5 second fuze.

A.—*It consists* of a cone of beech-wood, bored with a *central channel* and two powder channels; round

the head is turned a groove communicating with the central channel by two fire holes. The central channel is lined with a paper tube, shellac varnished, and into this is driven 2 inches of mealed powder. The powder channels are filled with pistol powder, and connected at the bottom with quick match.

The head of the fuze is closed with a gun-metal screw-plug, with a pin underneath it; round this are caught the ends of the quick match priming, which passing out through the fire holes is laid round in the groove and fastened. The priming is protected by a band of tape, copper, and tape, and outside all with paper. It is covered with paper and painted. It is marked on each side—on one side in half-seconds, as, 1, 2, 3, &c.; on the other in quarter-seconds, as, 1·5, 2·5, 3·5, &c.

Q.—What is the object of the paper lining?

A.—It prevents the formation of a space between the wood and the composition in the event of the wood shrinking.

Q.—What would happen if this space formed?

A.—The flash would pass down it, and the fuze would act prematurely.

Q.—Why is the head closed with a metal plug?

A.—To diminish its rate of burning when fired from rifled guns, and also to prevent its being extinguished when striking point first.

Q.—Why is it marked in quarter-seconds?

A.—To enable us to regulate our bursts, with relation to the object, with greater nicety. This is of great importance when using the shrapnel shell.

Q.—In what does a 9 second fuze differ from a 5 second?

A.—*It contains* fuze composition instead of mealed

powder; is marked in half-seconds—even half-seconds on one side, odd on the other; and is painted black and drab instead of red and drab.

Q.—In what does the 15 second fuze differ from the above?

A.—It contains a slower-burning composition; has six powder channels; and it is marked spirally in half and quarter seconds, thus 1, 1·5, 2, 2·5, &c., up to 30.

Q.—In what respect does the 30 second fuze differ from the 15 second?

A.—It contains a still slower burning composition, is longer, and has eight powder channels. The lower part of the fuze is cylindrical, as, if the case were continued, there would be no room for the powder channels. The marking begins at 30 and goes up to 60.

Q.—Name the B.L. time fuzes.

A.—5 second, 9 second, 20 second, and 15 second.

Q.—In what respects do M.L. and B.L. time fuzes differ?

A.—As in B.L. guns there is no windage, and consequently no flash to ignite the primer, a detonating arrangement is necessary in the head of the fuze. This is like a percussion fuze in principle, having a safety pin through it and acting upon shock of discharge. The detonator is screwed in, and to prevent the head of the fuze splitting copper wire is wound round in a shallow groove. The B.L. fuze has also three gas escape holes, filled with quick match, the orifices being closed with thin discs of copper and kamptulicon wads, which are blown out by the gas. The B.L. fuze is longer than the M.L.

Q.—Is the time of burning of fuzes affected by height above sea-level?

A.—Yes, as the barometric pressure *diminishes*, the *time of burning increases*.

Q.—What allowance is to be made for this?

A.—For every 1000 feet above the sea-level bore the fuze $\frac{1}{30}$ shorter.

Example—Fuze 30 second. Height of battery 3000 feet. Subtract from length of fuze in boring 3 seconds; or, to illustrate it still more plainly, at 5000 feet above the sea-level a 30 second fuze would burn 35 seconds or $30 + \frac{5}{30}$.

Q.—How does age affect the time of burning of fuzes?

A.—Old fuzes burn longer, and therefore require to be bored shorter in proportion.

Q.—How do you know the age of a fuze?

A.—Each fuze is marked with the pattern and number made of that pattern; also with the month and year of manufacture; thus,

$$\frac{\text{(Mark) II.}}{\text{(Number) 300}} \text{ (Date) 3/75.}$$

Q.—What is an approximate rule for ascertaining length of fuze required for a certain range?

A.—Divide the number of hundreds of yards of range by 2, and add one for every thousand or part of a thousand yards.

Q.—Give an example.

A.—Range 1600.

$$\frac{16}{2} = 8 + 2 = 10$$

$\therefore$ 10 tenths is the length of fuze required.

Q.—Does this rule answer for shrapnel?

A.—Shrapnel requires to be burst short, therefore the rule is the same as above *except* that nothing is added for the *first* 1000 yards.

Example—Range 1600 yards.

$$\frac{16}{2} = 8 + 1 = 9 \text{ tenths.}$$

Q.—Is there not a simple rule for finding range from elevated battery?

A.—Yes, the rule is as follows:—

Height of battery above plane (on which object is situated) × 1146 ÷ angle of depression in minutes = range inwards.

Q.—Is there a simple way of finding approximate height of battery?

A.—Yes, if you can find a *precipitous* cliff near the battery (as is *often* the case), drop a stone, and note the number of seconds it takes to reach the beach; square this number and multiply by 16; the answer will be the height in feet.

Example—A stone takes 2 seconds to fall to beach, &c.

$$2^2 = 4 \times 16 = 64.$$

$\therefore$ the height of cliff is 64 feet.

Q.—Suppose with a B.L. gun in action your B.L. fuzes were used up, could you use M.L. fuzes?

A.—Yes, you would cut a groove in the lead coating of the projectile, along this you would lay a leader of gun-cotton (or quick match), which you would twist round the head of the fuze, and by this means the flash of discharge would be conveyed to the quick match priming.

Q.—Would you be likely to have gun-cotton at hand for use with fuze, as described?

A.—Yes, strands of gun-cotton with silk twist are issued in boxes for field service.

Q.—How is a B.L. fuze fixed in the shell?

A.—It is carefully screwed in by hand, and never to be struck or knocked.

Q.—Can the hook-borer be used for 30 second M.L. fuze?

A.—No, the gimblet borer must be used.

Q.—How would you define a time fuze?

A.—*A time fuze* is one that can be made to burst a *shell at any given* period of its flight, or after striking.

Q.—What is a good rule for adjusting the Armstrong time fuze?

A.—Deduct 6 from the number of hundreds of yards of range, for tenths of fuze.

Example—Range 1800 yards.

$$18 - 6 = 12 \text{ tenths of fuze.}$$

Q.—What is a simple rule for boring mortar fuzes?

A.—Add 17 to the number of hundreds of yards in the range for length of fuze in tenths of inches.

Example—Range 1800 yards.

$$18 + 17 = 35 \text{ or } 3{\cdot}5''.$$

Q.—What are percussion fuzes?

A.—Fuzes which act on graze or impact.

Q.—What are the percussion fuzes in the service?

A.—Pettman's general service, the Royal Laboratory, marks I. and II., the delay-action, and the direct-action.

Q.—Describe a Pettman's general service percussion fuze.

A.—This fuze consists of a *body* of gun-metal, a *top screw plug, plain brass ball, steady-plug, detonating ball, cone-plug, lead cup,* and *suspending wire.*

In the bottom centre of the top screw plug is a cup-shaped hole, between which and a like cup on the top of the steady-plug rests the plain ball; the top of the steady-plug is recessed and filled with detonating composition, which is protected by a ring of thin copper. It is pierced with three fire-holes. The detonating ball is of gun-metal, it is roughed or fluted, and coated with detonating composition, protected by a layer of sheep-gut, three layers of silk, two hemispheres of thin copper, another layer of sheep-gut, and two more layers of silk. It rests between the bottom of the steady-plug and the top of the cone-plug.

The cone-plug has a central hole filled with *mealed powder*, pierced down in the centre like a

friction tube, and two fire-holes; the brass suspending wire passes through its stem and rests on the bottom of the fuze. The lead cup supports the cone-plug and thus the other contents of the fuze.

Upon shock of discharge the steady and cone-plugs set back, shearing the suspending wire; the stem protrudes through the bottom of the fuze; the lead cup crushes up and jams into the under-cut, preventing rebound, the detonating ball being released from its supports. Upon impact the detonating ball is dashed violently against the body of the fuze, and explodes; the flash, passing through the fire-holes in the cone-plug, ignites the mealed powder, the flash from which, passing down into the shell, explodes the bursting charge.

In a B.L. gun the projectile has so stable an axis that the detonating ball may set back with the cone and steady plugs without being detached from its supports, and then the fuze may not act. In this case, on impact the steady-plug flies forward, and the plain ball, which from centrifugal force is kept revolving round over the ring of detonating composition, is dashed violently against the latter and explodes it, and, the flash passing down through the fire-holes, the fuze acts as already described.

Q.—What is the object of this arrangement?

A.—That the fuze may be available for use with both M.L. and B.L. guns.

That it shall not explode on passing through a wave, &c., but shall act on impact with the side of a wooden ship.

Q.—Does it require any preparation?

A.—No. It has simply to be screwed into the shell.

Q.—With what guns is the R.L. percussion fuze mark I. used?

A.—*Field guns* up to the 9-pr. inclusive.

Q.—With what guns is the R.L. mark II. used?

A.—With guns from the 9-pr. exclusive up to the 80-pr. R.M.L. and 7″ R.B.L. inclusive.

Q.—Will it act on graze?

A.—Yes, on graze or impact.

Q.—Describe the construction and action of the R.L. percussion fuze.

A.—It consists of a *body* of gun-metal, *guard* and *safety pin*, *cap* of detonating composition, *steel needle*, *lead plug*, and *bottom screw plug*.

The guard is a gun-metal cylinder, fitting inside the top of the fuze, and resting upon two wings or flanges on the lead pellet. The safety pin passes through it, and is of twisted wire. The cap fits in the top of the lead pellet, and immediately over it in the head of the fuze is fixed the steel needle. The lead pellet has a central hole down which the flash passes, and there is a corresponding hole in the bottom screw plug closed with a thin brass disc. A hole drilled in the head of the fuze over the safety pin contains the lead plug.

Upon shock of discharge the guard sets back, shearing the wings on the lead pellet, the top of which is jammed into the under-cut groove round the guard (in ramming home the lead plug sets back and closes the hole which was occupied by the safety pin). Upon impact the guard and lead pellet fly forward, and the detonating cap comes in violent contact with the steel needle and explodes; the flash passes down through the fire-hole, blows out the brass disc, and ignites the bursting charge of the shell.

Q.—What preparation does this fuze require?

A.—In a B.L. gun the safety pin is withdrawn just before entering the shell in the bore, and in an M.L. gun it is withdrawn after the shell is in the bore before ramming home.

Q.—Describe shortly the action, &c., of the delay-action fuze.

A.—The delay-action fuze is intended for use with the 64-pr. battering shell (64-pr. built-up gun, mark III.) with gas check. It consists of a *body*, percussion arrangement of *pellet* with detached *guard*, *suspending wire* and *steel needle*, *air-space*, and delay arrangement of fuze composition.

The principle of the action of this fuze on being fired is the same as that of an ordinary percussion fuze. The suspending wire is sheared, the guard sets back upon the pellet, and the detonator is fired on impact. The flash from the detonator, however, instead of passing immediately to the burster in the shell, passes through the air space and ignites the fuze composition contained in the channel in the bottom of the body, and this, burning 5 or 6 seconds before exploding the shell, allows the latter sufficient time to bury itself in the object before bursting.

Q.—Name the various kinds of copper friction tubes there are, and the guns they are severally used with.

A.—There are three different lengths, viz.: 2″, 3″, and 5″.

The 2″ is a special tube for the 7-pr. mountain gun.

The 3″ is used with guns up to the 80-pr. R.M.L. and the 7″ R.B.L. inclusive.

The 5″ is used with the 7″ R.M.L. gun and upwards.

Q.—Describe the construction and action of a copper friction tube.

A.—The tube is of copper, filled with mealed powder damped with methylated spirits, and pierced with a hole down the centre, to insure its instantaneous action. The top is closed with a plug of shellac putty, the bottom with a paper wad. A small cylinder called the nib-piece is fastened on at *right angles to* the top of the tube and over a hole *in it: it is kept* in its place by being bound with

copper wire and soldered. In it is placed the friction bar, which is roughed and coated with detonating composition, the end being turned up. The latter is kept in position by the end of the nib-piece being clenched down upon it. The whole is then covered with black varnish.

Q.—Are primers necessary with shrapnel shell?

A.—Yes. They are small gun-metal cylinders filled with pistol powder, and being screwed into the top of the wrought-iron tube under the fuze, serve to convey the flash from the latter to the burster.

Q.—How many kinds of wedge wads are there, and with what guns are they used?

A.—Two. In the larger wad the length of cane is 7·5″, and length of wedge 7″. In the smaller the cane is 6·5″, and the wedge 5·5″. The large one is for use with 9″ guns and upwards. The smaller for use with 64-pr., 80-pr., and 7″ R.M.L. guns.

Q.—What is their use?

A.—Being rammed home separately after the projectile, they prevent the latter from shifting when running the gun up.

They are only to be used with guns mounted on traversing platforms or Moncrieff carriages.

Q.—Are they ever to be used with guns on standing carriages?

A.—Only when firing at angles of depression.

Q.—Suppose, in firing heavy guns, wedge wads are not forthcoming, are any precautions necessary? and why?

A.—You would give the gun at least 3° of elevation before running up, and keep the rammer pressed home until that elevation was given.

To prevent the projectile slipping forward on withdrawal of the rammer, or if the carriage came *violently in contact* with the stops.

Q.—What are primers for vent-pieces of B.L. guns?

A.—Cylinders of leather paper driven with mealed paper like a tube, with three strips of red worsted attached to the exterior at one end.

Q.—How are they used?

A.—They are pressed into the vent, worsted end first.

Q.—What are tin cups?

A.—They are used with B.L. guns to prevent as much as possible the escape of gas.

Q.—Are they issued for service with all B.L. guns?

A.—No. Only for the 7″ R.B.L., with which gun they are used for service, practice, and exercise.

With the other B.L. guns they are used for practice only.

Q.—Why are they to be used on all occasions with the 7″?

A.—Because there is no copper ring round the face of the vent-piece, and if it were not for the tin cup the latter would be injured by the erosive action of the powder gas.

Q.—In what proportion are tin cups issued?

A.—In the proportion of one to every ten rounds.

Q.—How many natures of rockets are there in the service?

A.—"War," viz. Hale's pattern, and "signal."

Q.—How many natures of Hale's war rockets are there?

A.—Two, viz. the 24-pr. for garrison or siege service, and the 9-pr. for field service. They are painted red.

Q.—Before commencing practice with a converted gun what steps must be taken that you may at once *know if the inner* tube has become injured?

A.—*A screw of* paper is placed in the "tell-tale"

hole. If the tube is cracked this is blown out by the escape of gas and of course the practice is at once stopped.

Q.—Name a few of the points to be attended to in imparting instruction to recruits.

A.—Strict silence is to be enforced on all occasions.

Long explanations are to be avoided; the instructor placing each man in the position he is to occupy, or himself showing how every operation in detail should be performed.

A detachment at gun drill should on no account *pretend* to load or lay a gun; but the drill stores should be used, and every operation properly performed.

No recruit should be allowed to go to practice until he has been well instructed in laying guns, boring and fixing fuze, and preparing shell.

A portion of the time should be devoted to theoretical instruction, and the men constantly questioned on their various duties, &c.

Q.—Give a detail of all stores required for a round of 10″ common shell (and cartridge) to be used against wooden shipping.

A.—(No. 1) sights. (No. 2) iron pointed lever, elevating wheel, and assists 4 with side arms. (No. 3) iron pointed lever, elevating wheel, hoisting tackle, port-bar, and removes muzzle tampeon. (No. 4) side arms. (No. 5) traversing handles, running back tackles, and wedge wads. (No. 6) zinc cylinder, bucket filled, and brush. (No. 7) one Pettman's G.S. fuze, key, plug G.S., strap. (No. 8) to the cartridge store, where, assisted by 14, he prepares one 44 lb. charge of P. or 40 lb. charge of R.L.G. in zinc cylinder. (No. 9) transporting barrow and brush. (No. 10) assisted by 13 and 15 in the shell store, prepares one common shell with gas check attached, filled 20 lb. 2 oz. bursting charge in bag. *(No. 11) two* rammer ropes and assists with side.

arms and cartridge if required. (No. 12) one 5″ friction tube, lanyard, pricker, and vent-server.

Q.—Where are shell to be fuzed?

A.—At the head of the shell lift, or as much under cover as possible. Never in the shell store.

Q.—Before a 10″ gun behind a shield is reported ready for action, to what point should No. 1 particularly direct his attention?

A.—He should see that the stores provided by each number were correct and in good working order. That the sights and deflection leaves worked easily. That the mantlets could be worked with facility. That the *clip plates* were on the carriage. That the screw of paper was placed in the tell-tale. That the proper amount of oil was in the buffer. That the racers were swept, &c.

Q.—State the test for ascertaining that the amount of oil in the hydraulic buffer is correct.

A.—Run the gun up to the front stops, remove plug from filling-hole, and insert gauge, which should show $4\frac{5}{8}$″ depth of oil (the platform being at a slope of 4°).

Q.—With 9″ guns and upwards mounted in a barbette battery, does the service of the gun differ from that of a gun behind a shield?

A.—Yes. You have to use muzzle derrick instead of loading-bar, and you have no port-bar or mantlets. The absence of port-bar necessitates leading-block on muzzle derrick for rammer-ropes, and with a sunken-way a loading-stage and a leading block for hoisting tackle are required.

Q.—What are the "index reader" and "arc" on the floor for?

A.—When once range and line are obtained, the firing can be carried on by observing the graduations marked on the "index reader" and "arc" by *the pointers.*

Q.—Describe the manner of calculating the amount of deflection to be given when firing at a moving object (by thumb-rule).

A.—Multiply the estimated rate of moving in miles per hour by 5 for minutes deflection.

Q.—An ironclad moves across the front of a battery at the rate of 240 yards per minute, range 1000 yards; what deflection would you give to hit the centre of the ship?

A.—
$$\frac{\overset{3}{\cancel{24}}\,\cancel{0} \times \overset{30}{\cancel{60}} \times 5}{\overset{176}{\cancel{176}}\,\cancel{0}\ \overset{22}{\cancel{22}}\ 11} = \frac{450}{11} = 40\tfrac{10}{11}.$$

Ans. $40\frac{10}{11}$ minutes.

Q.—Is there an accurate rule for calculating the deflection necessary to a nicety?

A.—Yes, it may be calculated in this way:—

Let A = estimated speed.
„ B = range in hundreds of yards.
„ C = time of flight.

Then
$$\frac{A \times 1760 \times 36 \times C}{3600 \times B} = x.$$

x being deflection necessary (in minutes).

Q.—A ship is passing your battery, moving at 5 miles per hour, range 1000 yards, time of flight 3 seconds; calculate, by above, deflection necessary to hit centre of ship.

A.—Speed = 5 miles.
Range = 1000 yards.
Time of flight = 3 seconds.

Then
$$\frac{5 \times \overset{44}{\cancel{1760}} \times \overset{176}{\cancel{36}} \times 3}{\underset{100}{\cancel{3600}} \times \cancel{10}\ 25} = \frac{660}{25} = 26\tfrac{10}{25}.$$ Ans.

By thumb rule it would be $5 \times 5 = 25$.

Q.—What is the value of one minute on the deflection scale?

A.—One minute on the deflection scale gives 1 inch per 100 yards of range.

Thus one minute right deflection would, on a calm day, cause a shot to strike 10 inches to the right of the point laid on, at 1000 yards range.

Q.—Is not this the foundation of a rule for correcting errors in shooting?

A.—Yes. If your shell fall to the right or left of the object,

Rule: Reduce the error to inches, and divide by hundreds of yards of range for minutes deflection necessary.

Q.—In firing at a target your shell is observed to fall, owing to wind blowing across the range, 3 feet to the right; range 1200 yards; what deflection is necessary to correct error, and to which side is it to be given?

A.—Error = 3 feet right. Range = 1200 yards.

Then, $$\frac{3 \times \cancel{12}}{\cancel{12}} = 3.$$

∴ 3 minutes deflection would be given towards the windward side, in this case "left."

Q.—Does this rule apply equally to elevation?

A.—Yes.

Q.—Then suppose, in firing at a 12 foot target, at 1000 yards, your shell is observed to hit the bottom edge of target, how many minutes more elevation must you give to hit centre?

A.—Error of course = 6 feet (half target).

Range = 1000 yards.

Then, $$\frac{\overset{3}{\cancel{6}} \times 12}{\underset{5}{\cancel{10}}} = \frac{36}{5} = 7\tfrac{1}{5}.$$

Therefore $7\frac{1}{5}$ minutes more elevation would be *required to hit* the centre of the target.

Q.—Suppose in firing with 3° elevation with a field gun, your right wheel has sunk 12 inches, what deflection would you give to correct error, and to which side would you give it?

A.—Rule: Multiply the number of inches of wheel below the level by the number of degrees of elevation at which you are firing for deflection necessary, to be given towards the higher wheel.

In the case cited—

Error = 12 inches.
Elevation = 3°.
$\therefore$ 12 × 3 = 36 minutes.

$\therefore$ 36 minutes left deflection would be necessary.

If the error of level is ascertained by quadrant, then—

$$\frac{\text{Number of minutes error of level} \times \text{degrees of elevation}}{60} = \text{Deflection necessary.}$$

Q.—Suppose a gun is spiked, how could you fire it?

A.—You would attach a quick match or gun-cotton leader to the cartridge, one end of which would hang out at the muzzle. By lighting the muzzle end by means of a port fire you could fire the gun.

Q.—How can breech-loading guns be easily rendered useless to the enemy?

A.—By carrying away the vent-pieces.

Q.—Suppose, in firing case from a 9″ gun, the recoil is not sufficient to enable you to reload, and you do not wish to lessen the quantity of oil in the buffer, what would you do?

A.—Double shot the gun.

Q.—Suppose a shell, in loading, jams in the bore, how would you proceed?

A.—Drown the cartridge by pouring water down the vent. Then very carefully pour fine-grain *pistol powder* down the vent by means of a horn,

paper tube, &c., and fire a tube. Care must be taken that the number firing stand well clear, as there is a great rush of gas from the vent.

Q.—Suppose, after a miss-fire, it is found upon examination to have been caused by imperfect ramming home, to what point must attention be paid before ramming home again?

A.—Care must be taken that the vent-server is in the vent.

Q.—How was a gun ingeniously disabled by a native gunner in the Afghan campaign?

A.—He inserted his turban and rammed it home. (It is very improbable that the enemy "searched" the gun before loading.)

Q.—Suppose you were in charge of a magazine, and were asked to take in small-arm ammunition or friction tubes, &c., what answer would you make?

A.—"See you darned first!"—(utterly refuse).

Q.—What should be the position of the range party, when solid shot is being fired?

A.—About 150 yards on the flank.

Q.—Also when common shell or shrapnel are used?

A.—About 100 yards short of the target and 500 yards to the flank.

Q.—Is there not a handy rule by which you can calculate elevation necessary for B.L. guns, when, at out stations, the sights are only marked in degrees, and a range table is not available?

A.—Yes. Subtract 4 from the hundreds of yards of range, and divide the remainder by 3. Answer = elevation approximately.

Q.—According to this, what would be elevation required with a 7″ B.L. gun at 1600 yards?

A.—

$$16 - 4 = 12$$

$$\frac{12}{3} = 4$$

Ans. 4 degrees.

Q.—What elevation is given by the range table under the same circumstances?

A.—As nearly as possible the same.

At 1800 the range table gives 4° 30′.

By the thumb rule it is

$$18 - 4 = \frac{14}{3} = 4° 40' \text{ about.}$$

Q.—Why are men taking post on the gun made to uncover in echelon outwards?

A.—If when *covering* a shot hit or passed through the man in front, it would kill the man in rear also, but by making them uncover each other, only one man would be killed at a time.

Q.—Why are handspikes always laid "bevel side up"?

A.—If, when laid down bevel side *downwards*, a man trod violently on the point of the handspike, the latter would probably fly up and hit him in the face.

Q.—Why are men using handspikes to elevate the breech of a gun cautioned to "keep the *hands together* at the small end"?

A.—Because in using the handspike thus, as a lever of the "first order," the power gained is in proportion as the length of lever exceeds the length of counter-lever. By having the hands at about 2 feet apart the man would have to exert much more power to move the weight.

Q.—Give an example.

A.—The preponderance of a 64-pr. is 6 cwt.; therefore, in raising the breech, each man has, of course, 3 cwt. to lift.

We will take Case 1, hands together.

Case 2, hands 2 feet apart.

Case 1:

$$\text{As } P : W :: CL : L$$
$$x : 3 \text{ cwt.} :: 1 \text{ foot} : 5 \text{ feet.}$$
$$\frac{3 \times 112}{5} = \frac{336}{5} = 67\tfrac{1}{5} \text{ lbs.}$$

or the man has to exert a power of 67⅓ lbs. on the end of the handspike.

Case 2:

As P : W :: C L : L
x : 3 cwt. :: 1 foot : 4 feet

$$\frac{3 \times 112}{4} = \frac{336}{4} = 84 \text{ lbs.};$$

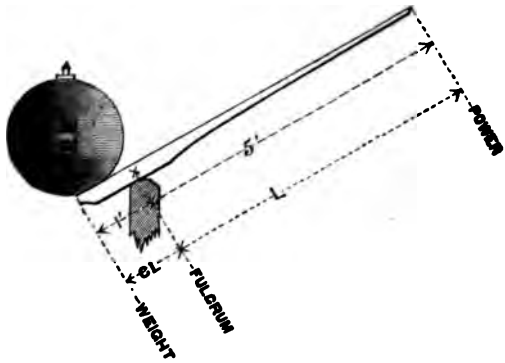
or a difference in the power required of 16⅔ lbs.

Q.—Why, when the hands are *two feet* apart, do you only take the lever as reduced *one foot?*

A.—Because the centre of effort lies midway between the two hands.

Q.—Show by a sketch the handspikes, marking L, C L, &c.

A.—



Q.—What is preponderance?

A.—The excess of weight in rear of the trunnions.

Q.—Have all heavy guns preponderance?

A.—*The* heavy built-up guns have hardly any, so *that the* centre of the trunnions may always be *taken as the* centre of gravity.

Q.—Is not bad shooting often caused by inattention of No. 1 to certain practical points?

A.—Yes.

Q.—Name some of them.

A.—No. 1 often has unintentional elevation or deflection on his scale, because the barrel-head (where sight so fitted) or deflection leaf are not at zero, or because he does not notice that his tangent scale has dropped; this is a very common error.

Care should be taken that the *last* motion of the elevating screw is one of *depression*, so as to bring the *elevating screw into bearing*, otherwise the slightest preponderance, or even, with field guns, the act of inserting the friction tube, will give elevation.

This play of the screw is called "*backlash.*"

In a much worn screw (field gun) it will often amount to as much as 15′ or 20′ elevation.

Q.—What is the cause of the wearing of the screw? and what precaution is taken to prevent it shifting?

A.—It is the result of excessive "spit-and-polish"!

When No. 1 finds the screw is loose, he should, after laying, move the lever into a cog that will bring it against the left wheel or bracket, and this effectually prevents its shifting further.

Q.—What about level of wheels?

A.—Inattention to level of wheels, or to any variation in the level between rounds, often causes bad shooting. It should, of course, be noted and allowed for on the deflection scale.

Q.—Name the points with reference to position of eye, &c., which require attention.

A.—Bad shooting is often caused by the *eye being kept too near* the *tangent sight* in laying. The tip of the fore sight will not then show *sharp* against the centre of the notch of the hind sight.

A gun is also often laid with a "half" or "fine" *sight; and* although the practice from a single gun

may be good, it is distinctly wrong for many reasons:—

1st. Because *all* the *service sights* (for heavy guns) are *graduated* for a *full sight.*

2nd. *Range*, as reported by the officer or No. 1 to the No. 1 of the next gun, would be *misleading*, as, by laying with a "fine sight," the former would, in reality, have been laying with *less* elevation than that recorded on the tangent scale.

3rd. In rapid firing a "fine sight" very soon tires the eye.

Q.—Show by sketch "fine," "half," and "full" sights.

A.—

"Fine."

"Half."

"Full."

Q.—Define a "full" sight.

A.—The tip of the bore sight to be in centre between, and level with, the shoulders of the notch of the hind sight.

Q.—Does not imperfect ramming home of the charge also cause bad shooting?

A.—Yes. If the charge is not rammed home the range is reduced.

Q.—All these causes of bad shooting can be guarded against. Is there any constant source of error with field guns which cannot be calculated?

A.—Yes. Namely, the "*jump*," or the tendency, on discharge, of the gun and carriage to revolve in a vertical direction round the point of the trail.

Q.—*What* can be done to meet this?

A.—*All* we can do is to have the trail on as hard *and level ground* as possible. Soft ground is always

bad, as the trail buries itself deeper every round, and gives a *varying* amount of "jump."

A plank, in this case, must be used under the trail.

Q.—Are range tables to be considered absolutely correct?

A.—No; only approximately so.

Q.—Why is this?

A.—Because made from data which may vary considerably; e. g. brand of powder, height above sea-level, density of atmosphere, force of wind, &c.

Q.—What regulates the ranges of mortars, there being no scale used?

A.—The amount of charge.

Q.—Is there any rule for this?

A.—Yes. Rules:—

13″ mortar,

$$\text{Range} + \tfrac{1}{2}\,\text{R} \times \cdot 03 + 10 = \text{charge in oz.}$$

Example—800 yards range.

$$800 + 400 = 1200$$
$$\cdot 03$$
$$36 \cdot 00$$
$$10$$
$$46 \text{ oz.} \quad \text{Ans.}$$

10″ mortar,

$$\text{R} + \tfrac{1}{2}\,\text{R} \times \cdot 02 = \text{charge in oz.}$$
$$800 + 400 = 1200$$
$$\cdot 02$$
$$24 \cdot 00$$
$$= 24 \text{ oz.}$$

8″ mortar,

$$\text{R} + 20 \times \cdot 02 = \text{charge in oz.}$$
$$800 + 20 = 820$$
$$\cdot 02$$
$$16 \cdot 40$$
$$= 16 \cdot 4 \text{ oz.}$$

Q.—What is the power of the service crab-capstan?

A.—13 to 1.

Q.—What is the power of the triangle gyn?

A.—The power of the windlass = 19·77 to 1
Power of tackle = 6 „

Total = 118·62 to 1.

Q.—Winch?

A.—From 56 to 1 upwards to 150 to 1.

Q.—Sling-wagon?

A.—Power = 35·6 to 1.

Q.—What is the power of the Gibraltar gyn, and what powers are gained by wheel purchase and parbuckle rope?

A.—Gibraltar gyn, 115·47 to 1.
Wheel purchase, 2 to 1.
Parbuckle rope, 2 to 1.

Q.—Name the jacks in the service, and the powers of each.

A.—Field service, P = ½ ton.
Clarke's, P = 5 tons.
Hydraulic, P = 7½ to 22½ tons.
Haley's screw, P = 15 „

Q.—What are some of the main points to be attended to in the use of the hydraulic jack?

A.—They must be kept in serviceable condition, free working order, &c., and not strained.

Care should always be taken to have a *firm base*, to keep the jack *vertical*, and work with *regular* strokes; that iron does not come against iron, but that chips of wood, or tow, &c., are placed between. To build up under the rising weight with skidding, and follow up with scotches, so that, if the jack gives way, there may be no accident; and to ease off carefully and not suddenly.

Q.—What are the triangle gyns in the service, and what weight may be lifted by each?

A.—The 16 foot gyn weighs 9 cwt., will raise *70 cwt. if fitted* with wrought iron, 60 cwt. if fitted *with cast iron.*

18 foot light gyn weighs about 13 cwt., and will raise about 7 tons if fitted with wrought iron, 6 tons if fitted with cast iron.

18 foot heavy gyn weighs (wood) about 26 cwt.; (iron) about 27 cwt., and will raise 12 tons.

Q.—Of what does a 16 foot gyn tackle consist?

A.—Of 1 double and 1 treble 10″ bothways block, rove with 15 fathoms of 3½″ fall.

Q.—Describe an 18 foot light gyn tackle.

A.—It consists of 2 treble 12″ bothways blocks, and 18 fathoms of 4″ fall.

Q.—What is the difference between this and the tackle for 18 foot heavy gyn?

A.—The latter consists of 2 treble 15″ blocks, rove with 18 fathoms of 5″ fall.

Q.—How can you tell the difference between "cast-iron" and "wrought-iron fittings"?

A.—By the teeth on the windlass-ratchets.

When of cast iron, they are hog-backed; thus,

When of wrought iron, they are straight; thus,

Q.—What is the minimum splay allowed in carrying a gyn?

A.—10 feet.

Q.—What is the maximum splay allowed in working gyns?

A.—For 18 foot heavy gyn it is 15 feet.
For 18 foot light gyn it is 13 feet.
For 16 foot light gyn it is 12 feet.

Q.—How is the splay of a gyn measured?

A.—From a perpendicular let fall from the centre of the windlass to the pry-pole.

Q.—What is the *front* of a gyn?

A.—*The* pry-pole.

Q.—When from want of room a gyn cannot be carried or lifted, how may it be moved?

A.—The shoes being placed under the feet, it may be hauled by means of drag-ropes on the cheeks and pry-pole.

Q.—What are some of the main points to be attended to in the use of gyns?

A.—The head of the gyn should always be exactly over the centre of gravity of the weight to be raised. The maximum splay should not be exceeded.

The feet should be on the same level, and properly supported.

Before taking the weight the pry-pole should be lashed to the cheeks.

The foot of the pry-pole should be equidistant from the feet of both cheeks.

A weight may be hauled towards the centre of the windlass or towards the pry-pole, but never towards the flank.

The weight should be kept from swinging about by means of steadying ropes or tackles.

Q.—In carrying the gyn is any precaution taken to prevent the pry-pole separating too far from the cheeks?

A.—Yes. The pry-pole is secured by a drag-rope to the windlass.

Q.—What weight may be "eased off round the windlass"?

A.—Up to and not exceeding 5 tons.

Q.—If you are going to leave a gun suspended by a gyn, what precaution do you take to lessen the strain on the tackle?

A.—Ease off one complete turn round the windlass. This relieves the tackle of the strain due to friction, which is $\frac{1}{8}$ W. for every sheave in use.

With two treble blocks raising 10 tons the actual strain on the tackle amounts to 18 tons; thus by *"easing off"* and taking off the $\frac{8}{18}$ due to friction, we *only have the* actual weight of 10 tons to sustain.

Q.—What is the rule about placing a gyn over a gun on a traversing platform?

A.—The cheek furthest from the pivot is to be nearest to the platform.

Q.—How many kinds of blocks are there in the service?

A.—Two. "Bothways" and "Admiralty."

Q.—Describe them.

A.—Bothways blocks are iron-strapped, the strapping passing inside the shell, and affording a better support to the pin than the ordinary block does.

In consequence of the pin, upon which the sheave turns, being better supported, it can be of less diameter than in the ordinary block, thus reducing friction. These blocks are fitted with swivel hooks.

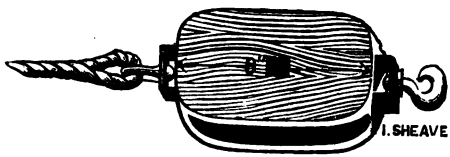
Admiralty blocks are rope strapped, the hook or thimble being seized into the bight of the strap.

Q.—How are blocks distinguished?

A.—By the length of their shell in inches, and by the number of sheaves, thus: an "8" double block."

Q.—Sketch an Admiralty and a bothways block.

A.—



"Bothways" block, an "8" single."

"Admiralty block."

Q.—How are ropes distinguished?

A.—By their circumference in inches.

Q.—How many fathoms are there in a whole coil of rope?

A.—113 fathoms.

Q.—Is there any simple rule for calculating the weight of a coil of rope?

A.—Yes. Circumference in inches squared × by length of coil in fathoms ÷ 480 = weight of coil in cwts.

Example—W of 14 fathoms of 6″ rope?

$$\frac{\overset{7}{\cancel{14}} \times 6 \times \overset{3}{\cancel{6}}}{\underset{\cancel{80}}{\underset{\cancel{40}}{\cancel{480}}}} = \frac{21}{20} = 1\tfrac{1}{20} \text{ cwt.}$$

Q.—What is the rule for finding safe working strain of *new* rope?

A.—Square the circumference in inches and divide by 7. Ans. = strain in tons which rope will bear.

Q.—What weight may be put upon a 5″ new rope?

A.—
$$\frac{5 \times 5}{7} = \frac{25}{7} = 3\tfrac{4}{7} \text{ tons.}$$

Q.—What is the rule for worn rope?

A.—Square the circumference and divide by 8.

Q.—What weight will a 4″ worn rope bear?

A.—
$$\frac{\overset{2}{\cancel{4}} \times 4}{\underset{2}{\cancel{8}}} = 2 \text{ tons.}$$

Q.—What per-centage is gained by using thimbles over hooks?

A.—28 per cent.

Q.—Is there not a simple rule for calculating the strain a chain will bear?

A.—Yes. Square the diameter of the link in $\frac{1}{8}$ of *inches, and cut off* the last figure as a decimal. *Ans. = weight it* will bear in tons.

Q.—By this rule what strain will an inch and a half chain bear?

A.—

$$1\tfrac{1}{2} \text{ inches} = \frac{12}{8};$$

$$\therefore 12 \times 12 = 144 = 14{\cdot}4 \text{ tons.}$$

Q.—How would you reeve a tackle?

A.—Place the blocks about 6 feet apart, hooks in opposite directions, the fall, coiled up neatly and free to run, on the right of the block having the greater number of sheaves. Place two men back to back between the blocks; reeve by passing the fall first through the *bottom sheave* of the block with *most* sheaves, then through the bottom sheave of the other block, and so on. When the fall is rove the standing end is made fast with an inside clinch to the thimble of the block with the least sheaves.

Q.—Are there any exceptions to this rule?

A.—Yes. A whip upon whip, gyn tackles, and left gun tackles.

The latter are rove in the same way, except that the fall is *first* passed through the *upper* sheave.

Q.—How do you calculate the power of a tackle?

A.—By the number of returns coming from the movable block.

Q.—May the full weight be put on?

A.—No. Because $\frac{1}{8}$ W has to be added to W for every sheave in use on account of friction.

Q.—How, then, can you find the weight (W) which can be raised by a given tackle?

A.—Find W one return will bear; multiply this by number of returns from running block. Answer, less $\frac{1}{8}$ W for every sheave in use, = W tackle will bear.

Q.—What W can be raised by two treble 18″ blocks rove with 6″ fall passing through leading block?

A.—*The tackle* will bear 27 tons.

$$W - \tfrac{1}{15}W = 14$$
$$\tfrac{14}{15}W = 210$$
$$\therefore \tfrac{1}{15}W = 210$$
$$W = \frac{210}{15} = 14\tfrac{6}{15} = 14\tfrac{2}{5} \text{ tons.}$$

4.—In same rule what weight will a half tackle lift?

A.—Half tackle consists of 2 double and 1 single pulley, rove with 2" fall.

$$\frac{1 \times 1}{2 \times 2 \times 2} = \frac{35}{W} \times \frac{8}{1} = \frac{35}{4}$$
$$\therefore W - \tfrac{1}{8}W = \frac{35}{4}$$
$$\tfrac{7}{8}W - \tfrac{1}{8}W = 35$$
$$\tfrac{6}{8}W = 35$$
$$W = \frac{35}{\frac{6}{8}} = 46\tfrac{2}{3} \text{ tons.}$$

5.—Power and weight being known, how can we find what circumference rope required?

A.—W = 5 tons as usual shown in use × 5 and ÷ by power 1 ton = 5 tons = size of rope required.

6.—What rope will be required for a tackle consisting of 2 treble blocks to raise a W of 5 tons (½ added)?

A.—
$$\frac{W \times \frac{1}{2}}{\text{power}} = \text{tons.}$$
$$\frac{\quad \times \quad}{\quad} = W$$
$$\frac{\quad \times \quad}{\quad} = \quad$$
$$\quad = \quad$$
$$\quad = \quad$$
$$\quad = \quad \text{tons.}$$

Therefore a [illegible] rope would be required.

Q.—What is the least-sized rope (worn) that will ear a strain of 2 tons?

A.—

$$2 \times 8 = 16$$

$$4)\ 16\ (4$$
$$16$$
$$\therefore \text{ Ans. } 4''.$$

Q.—Given tackle, and power exerted, how do you ind out what W a tackle is lifting?

A.—P (power) × by P of tackle gives total W ifted, including friction.

Q.—Work out the following example: Two double locks, giving P of 4 to 1, P applied at running nd of fall 2 tons, required W lifted.

A.—

$$2 \times 4 = 8$$
$$\therefore\ W + \tfrac{1}{3}W = 8$$
$$\therefore\ 8W + 4W = 64$$
$$\therefore\ 12W = 64$$
$$\therefore\ W = \frac{64}{12} = 5\tfrac{4}{12}\tfrac{1}{3} \text{ tons.}$$

Q.—What is "fleeting" a tackle?

A.—Bringing the blocks close together.

Q.—What is "overhauling" a tackle?

A.—Separating the blocks.

Q.—What additional per-centage of strain is caused y using tackle the pin and sheaves of which are ot clean and in good order?

A.—27 per cent.

Q.—What extra strain is caused by a turn in the ackle?

A.—40 per cent.

Q.—What is a lever of the "first order"?

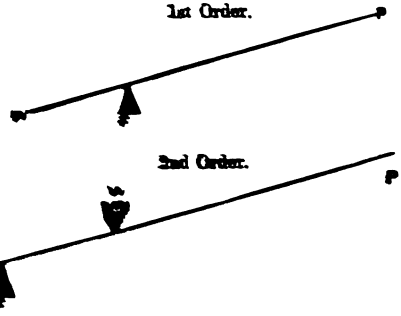
A.—A lever is of the first order when the fulcrum s between the weight and the power.

Q.—*What is* a lever of the second order?

A.—*When the* weight is between the fulcrum and *e power.*

Q.—Show both by sketch.

A.—



Q.—What are the most familiar examples?

A.—In "elevating" a gun a handspike is used as a lever of the first order.

In "running up" it is used as a lever of the second order.

Q.—What is the formula for calculating questions of leverage?

A.—As the power applied is to the weight, so is the length of the counter-lever to the lever.

Q.—What is the "lever," the "counter-lever," &c.?

A.—The lever is the portion of the lever between the P (power) and the fulcrum.

The counter-lever is the portion between the fulcrum and the weight.

Q.—What signs and letters do you generally use in leverage and other questions in mechanics?

A.—P = power; F = fulcrum; W = weight; L = lever; C L = counter-lever, &c.

Q.—Show how the formula is used.

A.—As P : W :: *C L* : L. The italic letters are called the *interiors*, the roman ones the exteriors. *Given the interiors* and one of the exteriors, multiply *interiors* together, and divide by the known

exterior, and the answer will be the exterior wanted, and *vice versâ*. Thus, if any three are given, the fourth can be found.

Q.—Exemplify this.

A.— P : W :: C L : L.

If P is wanted,

$$\frac{W \times CL}{L} = P.$$

If W is wanted,

$$\frac{P \times L}{CL} = W.$$

If C L is wanted,

$$\frac{P \times L}{W} = CL.$$

If L is wanted,

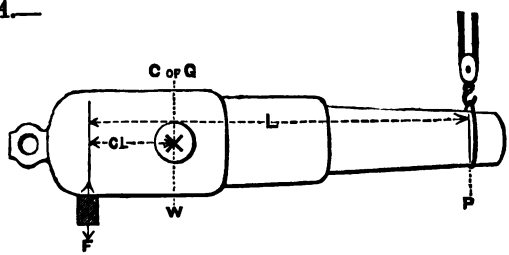
$$\frac{W \times CL}{P} = L.$$

Q.—In calculating strains on tackles, levers, &c., in raising heavy guns, can the *gun* be taken as a lever for the purpose of working the calculation?

A.—Yes, as a lever of the second order; the centre of gravity being taken as W, the point where the P is applied to the fulcrum as L, and from W to fulcrum as C L.

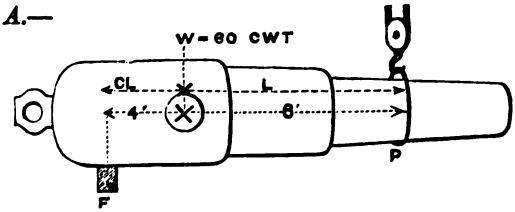
Q.—Show it by a sketch.

A.—



Q.—By this rule work out the following example:—A gun, weighing 60 cwt., is raised at muzzle 8 feet *in front of* C. of G. by a tackle; it is skidded 4 feet *in rear of* C. of G.; what P is required at the tackle?

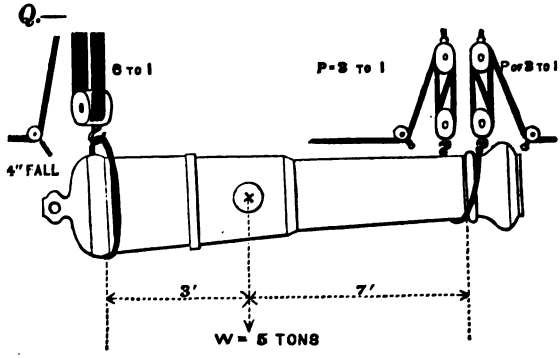
A.—



$$P : W :: CL : L$$
$$x : 60 :: 4 : 10$$
$$\frac{\overset{6}{\cancel{60}} \times 4}{\underset{}{\cancel{10}}} = 24 \text{ cwt.}$$

Therefore a P of 24 cwt. must be exerted by the tackle to raise the muzzle.

Q.—



A 5-ton gun is being raised, as shown; calculate by the tackle rules and lever rules, allowing for friction ($\frac{1}{8}$ for each sheave in use):—

1st. W on each muzzle tackle, including friction.

2nd. W. on breech tackle, do. do.

3rd. Strain on running end of fall of each muzzle tackle.

4th. Do. do. breech do.

5th. Will each fall be strong enough to bear the *strain put upon it* (part-worn rope being used in each *case)?*

A.—1st. P : W :: C L : L
x : 100 :: 36″ : 120″

$$\frac{\overset{5}{\cancel{100}} \times \overset{3}{\cancel{36}}\ \overset{18}{\cancel{18}}}{\underset{6}{\cancel{120}} \times 2} = 15 = \text{W on each muzzle tackle;}$$

$$\therefore 15 + \left(\frac{4}{8} \times \frac{15}{1}\right) = 15 + 7\tfrac{1}{2} = 22\tfrac{1}{2} \text{ cwt.}$$

$22\frac{1}{2}$ cwt. = W on each muzzle tackle, including friction.

2nd. P : W :: C L : L
x : 100 :: 84″ : 120″

$$\frac{\overset{5}{\cancel{100}} \times \overset{14}{\cancel{84}}}{\underset{6}{\cancel{120}}} = 70 \text{ cwt.} = \text{W on breech tackle;}$$

$$\therefore 70 + \left(\frac{7}{8} \times \frac{70}{1}\right) = 70 + 61\tfrac{1}{4} = 131\tfrac{1}{4} \text{ cwt.;}$$

∴ strain of breech tackle including friction = $131\frac{1}{4}$ cwt.

3rd.
$$\frac{\overset{15}{\cancel{45}}}{2 \times \cancel{3}} = \frac{15}{2} = 7\tfrac{1}{2};$$

∴ strain on running end of fall of each muzzle tackle = $7\frac{1}{2}$ cwt.

4th.
$$\frac{\overset{175}{\cancel{525}}}{4 \times \underset{2}{\cancel{6}}} = \frac{175}{8} = 21\tfrac{7}{8};$$

∴ strain on running end of breech tackle = $21\frac{7}{8}$ cwt.

5th. Fall of muzzle tackle, $2\frac{1}{2}$″ rope.

$$\frac{5 \times 5 \times \overset{10}{\cancel{20}}}{2 \times 2 \times 8} = \frac{125}{8} = 15\tfrac{5}{8} \text{ cwt.}$$

Strain muzzle tackle will bear = $15\frac{5}{8}$.
Strain put upon it = $7\frac{1}{2}$ cwt.

Fall of breech tackle, 4″ rope.

$$\frac{4 \times 4 \times \overset{2}{\cancel{20}}}{\underset{2}{\cancel{8}}} = 40 \text{ cwt.}$$

Strain breech tackle fall will bear = 40 cwt.
Strain put upon it = $21\frac{7}{8}$ cwt.

Therefore the strain in neither case is greater than the rope is calculated to bear.

Q.—A 43-ton gun and carriage were being moved on a sleigh upon rollers. The P employed was a double block on the W, and a single block at the holdfast. The running end of the fall was led through a leading block (at an angle of 30° from the line of travelling) to service capstan (affording power of 13 to 1). Resistance to rolling = $\frac{1}{40}$ W. Find strain on capstan.

A.—W = 43 tons + 8 + 3 + (material, &c.) 1 = 55 tons.

$$\frac{55}{40} = 1\tfrac{15}{40} = 1\tfrac{3}{8} = \text{R not including friction.}$$

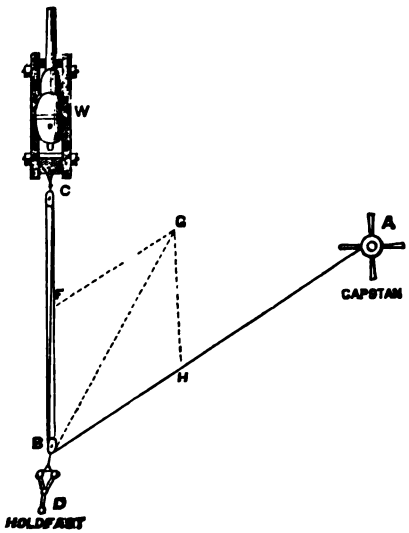
$$\text{R including friction} = \frac{11}{8} + \left(\frac{4}{8} \times \frac{11}{8}\right) = \frac{11}{8} + \frac{44}{64} = \frac{11}{8} + \frac{11}{16}$$

$$= \frac{22 + 11}{16} = \frac{33}{16} \div 4 = \frac{33 \times 1}{16 \times 4} = \frac{33}{64} \text{ tons;}$$

$\therefore$ strain on barrel of capstan = $\frac{33}{64}$ tons.

Q.—Find by construction the strain on the leading block.

A.—



On any scale set off B F, BH ($\frac{33}{64}$ tons to equal 1″). Complete parallelogram B H G F. Measure B C on same scale. Then—

$$B\,C = 1\tfrac{11}{16}''.$$

∴ strain on leading block

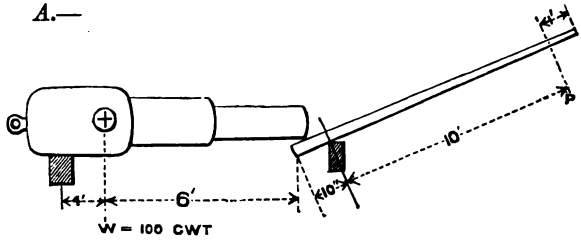
$$= \frac{33}{64} + \left(\frac{11}{16} \times \frac{33}{64}\right) = \frac{363}{1024} + \frac{33}{64} = \frac{363 + 528}{1024} = \frac{891}{1024}\text{ tons} = \frac{891 \times 20}{1024}$$

$= 17\frac{103}{256}$ cwt.

Therefore the strain on the leading block (D) $= 17\frac{103}{256}$ cwt.

Q.—A 5-ton gun is skidded 4 feet in rear of C. of G. The muzzle (6 feet from C. of G.) is raised by a 12 foot lever applied over a fulcrum which is 10″ from muzzle. What P is it necessary to apply 1 foot from end of lever to raise muzzle?

A.—



$$P : W :: C\,L : L$$
$$x : 100 :: 48'' : 120''$$
$$10'' : 120''$$

$$\frac{100 \times \overset{4}{\cancel{48}} \times \cancel{10}}{\underset{30}{\cancel{120}} \times \underset{12}{\cancel{120}}} = \frac{100}{30} = 3\tfrac{\cancel{10}}{\cancel{30}^{3}};$$

∴ P required = $3\frac{1}{3}$ cwt.

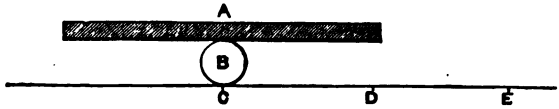
Q.—What is a movable fulcrum?

A.—When a lever is applied under a moving weight, a roller is used as a fulcrum, so that it may travel with the weight.

Q.—What is the rule about the relative rate of moving of rollers and weight?

A.—*A weight* (moved on a roller) moves exactly *double the distance* traversed by the roller.

Example—



While the point A on the baulk had moved from C to E, the roller would only have moved from C to D.

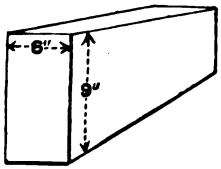
Q.—What is a handy rule for calculating W of 3 foot oak skids?

A.—Width × depth = W in lbs.

Example—

6″ by 9″ oak skid.

6 × 9 = 54 lbs.



Q.—How are stores described in returns, &c.?

A.—Backwards!

Q.—How would you describe one rat-trap?

A.—Traps—rat—wire—of sorts—one.

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